The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

VOL. XXXIII. December 28, 1935 No. 861

The Chemical Industry in 1935

THE year of the Royal Silver Jubilee draws to its close, and despite the storm clouds that at present hang over our national affairs we approach the New Year with confidence that the steady progress achieved during 1935 will lead to an even better state of affairs in 1936. The restrained optimism we expressed twelve months ago has been realised. The chemical industry is in a sounder condition, its output has been increased, its technical equipment has been improved, unemployment has been reduced, and the steady recovery which was just beginning to reveal itself a year ago has been substantially advanced. The return of the National Government at the General Election in November ensures confidence and stability, and it now remains for industry to formulate plans for its own advancement. To-day the British chemical industry has a personnel second to no other country, the deficiencies in this respect which existed in 1914 having been fully made up. There is close co-operation with the university laboratories and their staffs, who are becoming increasingly technically minded. There is a full and intelligent appreciation of the difficulties and problems of the industry by Government departments, notably the Board of Trade and the Home Office.

THE EDITOR AND PUBLISHER OF THE CHEMICAL AGE SEND THEIR BEST WISHES TO THE CHEMICAL AND ALLIED TRADES FOR A PROSPEROUS NEW YEAR

Evidence of the general expansion of the chemical industry is afforded by the Board of Trade returns issued last week, which contain the trade statistics for the eleven months ended November 30. During that period Great Britain exported chemicals, drugs, dyes and colours to the value of £18,707,360, against £18,060,545 in the corresponding period of 1934, an increase of 3½ per cent. Imports totalled £10,860,201, against £10,400,051, an increase of 4.4 per cent. Although the percentage increase of imports exceeded that of exports, the favourable trade balance (*i.e.*, the excess of exports over imports) rose from £7,660,494 in 1934 to £7,847,159 in 1935. In the first eleven months of 1933 the favourable trade balance was £8,020,551, so that the British chemical manufacturer still has some way to go to achieve that measure of recovery that is urged elsewhere in this issue by Mr. Eben Wallace, chairman of the Association of British Chemical Manufacturers. Re-exports for the eleven months amounted to £516,528 against £776,438 in the corresponding period of 1934, but there are so many fluctuating circumstances attending these transactions that it is impossible to draw any definite inference.

Thanks to the co-operation of recognised authorities in nearly a dozen different spheres of chemical science and industry we are able in this Annual Review Number of THE CHEMICAL AGE to present a more or less complete picture of the trend of events during 1935. Mr. P. Parrish, who has made a detailed study of conditions in the heavy chemical industry for several years, records that trade in 1935 has improved materially as contrasted with the two preceding years, and he anticipates a still further consolidation of British trade in the Future. Little change has occurred in the technique of the synthesis of ammonia, and efforts are now being directed to increasing the efficiency, and to the production of catalysts which are less susceptible to poisoning.

No review of the past twelve months would be complete without reference to the new petrol from coal hydrogenation plant at Billingham, formally opened in October by Mr. Ramsay MacDonald. The plant, which took eighteen months to build, is the first in the world to make petrol on a commercial scale by the hydrogenation of bituminous coal. The economics of the system have yet to be proved. The plant produces only four per cent. of the country's consumption of petrol, and employs nearly 4,000 tons of coal per day. In the hydrogenation process a coal-in-oil paste is treated under pressure with hydrogen, so that solid coal is transformed nearly quantitatively into petrol and gaseous hydrocarbons. The yield of petrol is between 60 and 70 per cent. by weight.

During 1935 the Chief Alkali Works Inspector intimated that the method hitherto obtaining for determin-

ing the total acidity of chamber plant escapes by absorption in hydrogen peroxide was unsatisfactory, in that it did not include all the acidity due to oxides of nitrogen. Investigations in the Chief Alkali Works inspector's laboratory have led to the development of a modified test.

Whilst the year has not seen any revolutionary change in the design and construction of chemical plant, there are signs of an increasing appreciation of the value of the chemical engineer in industry. Chemical engineering—that branch of engineering which relates to the design, construction, erection and operation of plant and works in which matter undergoes a change of state or composition—is now recognised all over the world as an important subject, and its contributions to increased efficiency during the past twelve months have produced beneficial results. Much more remains to be accomplished in the future. Few industries are likely to be free from competitive conditions of production, and the application of the quantitative technique of chemical engineering is likely to extend beyond the strictly chemical trades. Apart from sensational discoveries, the development of still more accurate methods of estimating plant performance quantitatively in advance may be anticipated. The tendency for manufacturing units to develop on mass production lines will doubtless lead to increased application of recovery processes and a greater attention to thermal efficiency.

In the field of colloid chemistry Mr. William Clayton gives a very scholarly review of a selection of the many investigations reported during the year. His selection has been made with particular reference to matters of a technical nature, pointing out, as one instance, that films which are built up by depositing successive monomolecular layers on a solid surface are of deep interest for the theory of orientation and wetting. Egg albumin is very much in evidence as a material for colloid study, among which food chemists will note the development of a new method for evaluating foaming power and foam stability. The subject of detergents is also one which has received a large amount of attention, one investigation having been concerned with the influence of *p*H on the surface tension of soap solutions. In all Mr. Clayton deals with over sixty investigations which can truly be considered as " colloid chemistry " with ultimate commercial applications.

Mr. A. J. Hall reviews in detail the advances made during 1935 in the preparatory treatments through which most woven and knitted textile materials pass and in the dyeing, printing and finishing processes to which they are afterwards subjected. Formerly Great Britain and Germany were mainly responsible for new developments in the bleaching, dyeing and finishing of textiles, but more recently the United States, Italy, Japan, Russia, and even China, have commenced to make valuable contributions to textile progress. The United States in particular is taking a much greater interest in research on textiles and it is believed that the examples of the British research associations for cotton, wool, linen and silk have done something to arouse this increased interest.

Professor T. P. Hilditch tells us in his review of fatty oils and soaps that nothing very exciting has happened in this field during 1935, that is to say, nothing with " news value," such as the discovery of a new vitamin of outstanding power or of a new product which will supersede all present-day soaps or make best dairy butter a commodity to be pitied rather than sought. The intensive studies now being devoted in the factory and the laboratory to all kinds of aspects of fats and detergents, their properties and uses, are, however, leading to marked progress of permanent value, perhaps more permanent than that which sometimes results from isolated and striking discoveries. In the production and refining of fatty oils the chief feature of the year appears to have been the further examination of recently suggested processes rather than the development of many new ones. There has been greater activity in the attempted standardisation of methods of technical analysis employed not only in process control but also in the marketing of fatty oils and soaps.

There has been a definite upward trend in the world consumption of nitrogen, although there is still a considerable excess of producing capacity over present requirements. After the years of depression the rising portions of the statistical curves in publications such as the latest report of the British Sulphate of Ammonia Federation are distinctly encouraging. The report of the Federation for 1934-35 which reached us as we went to press, shows that the total world consumption of nitrogen for the fertiliser year 1934-35 increased by 8.2 per cent. over that of the previous year, which in turn had shown an increased consumption of 7.5 per cent., preceded by a rise of 12.3 per cent. Dr. E. B. Maxted, in his review of the industry during the past twelve months, shows that attention continues to be directed towards a cheapening of the manufacture of the hydrogen which is a key constituent in determining the cost of synthetic ammonium salts.

In the sphere of chemistry concerned with the production, use and science of solvents, an outstanding feature of the year's progress has been the manufacture for the first time in England on a commercial scale of decahydro naphthalene at a price which permits its use industrially. It has been made for some years on the Continent, but the high price of the imported material previously available prevented its extensive use as a solvent in the paint and varnish industry. The English product is the fully hydrogenated substance, decahydro naphthalene, and Dr. T. H. Durrans records that an investigation of its properties and its adaptability for paint and varnish manufacture has been made by the research association of the trade concerned. Dealing with plasticisers, Dr. Durrans criticises our patent law, or the administration of it, for granting patents which confer no real protection upon the patentee and are a hindrance to general progress.

An agreement reached between the councils of the Chemical Society, the Institute of Chemistry and the Society of Chemical Industry with a view to closer co-operation and the appointment of a Chemical Council has conjured up visions, in the minds of a number of after dinner speakers, of central headquarters in which all the scientific organisations might be respectably housed. It is, however, too early yet to arrive at any conclusions as to how far co-operation will be carried, as there are many bodies outside the agreement. Every organisation has carried out a full programme of technical and social meetings, and in many instances increases in membership are reported. The British Association of Chemists has been deeply concerned about the new poisons regulations and has launched a campaign to secure such revisions as will afford due recognition of the qualifications of its members.

Presidential Greetings

Professor N. V. Sidgwick (The Chemical Society).

Professor Jocelyn F. Thorpe (The Institute of Chemistry).

Mr. W. A. S. Calder (The Society of Chemical Industry).

PRESIDENTS OF THE THREE PREMIER CHEMICAL ORGANISATIONS, 1935.

In view of the steps which have been taken during 1935 *to bring about a measure of closer co-operation between the three senior chemical organisations in this country, we print below special messages which we have received from the three presidents, all of whom write hopefully of more effective co-operation in future. Professor Thorpe goes further and suggests that the ideal contemplated by the signatories to the agreement will not be fully achieved until the chemical organisations are housed in one building.*

The Chemical Society

THE objects of the Chemical Society, as defined at a meeting held on February 23, 1841, to consider the formation of a Chemical Society, are: "The promotion of chemistry and of those branches of science immediately connected with it by the reading, discussion, and subsequent publication of original communications," and under the terms of the original Charter granted in 1848 the Society was established "for the general advancement of chemical science as intimately connected with the prosperity of the manufactures of the United Kingdom." The report of the Society's activities which will be published next week bears evidence that during 1935 the Society has continued to carry out the objects for which it was formed, and that our fellowship has been more than maintained.

In 1935, an important step has been taken towards co-operation between this Society, the Institute of Chemistry and the Society of Chemical Industry, the Councils of these three bodies having entered into an agreement to form a Chemical Council, which has for its object "the allocation of grants to the constituent bodies for charitable purposes, especially for the co-ordination of scientific and educational publications, the publication of new discoveries in chemical science and of their application to the arts and manufactures, the promotion of research, the maintenance of a library for research and education purposes and the provision and equipment of a suitable building or buildings." Henceforward, the future of the Society will be very closely linked up with that of the Institute of Chemistry and the Society of Chemical Industry, and I look forward with confidence to such co-operation proving of invaluable assistance in furthering the development of the science of chemistry in this country.—N. V. SIDGWICK.

The Institute of Chemistry

THE Institute of Chemistry entered this year on the second fifty years of its existence as a chartered body, and it is the hope of everyone who has the interests of chemistry at heart that during the next fifty years its success and usefulness to science may be enhanced. Founded originally as a qualifying body before the days when the universities that then existed granted degrees with chemistry as a special subject, it has seen the creation and gradual growth of these newer universities, and has witnessed some of the work it undertook to perform well established in competent hands. For the Institute was never intended to be, neither has it ever functioned, as a teaching body. Its duty has been to examine and qualify such candidates as pass the examinations it has set. When the universities themselves undertook this task for their own students the Institute accepted their examinations and has admitted their graduates to its Associateship. The Institute has never and never will set itself up as an examining body in competition with the universities. It still functions as an examining centre because there are many students who, even now, cannot pass through a university curriculum and who obtain their training at evening classes and elsewhere. As the entrants for the Institute's examinations are on the increase it is evident that this service is still required.

The functions of the Institute as a professional body which has the interests of the profession of chemistry in its keeping constitute its most important duties and cause it to be an essential complement to the Chemical Society and the Society of Chemical Industry. My term of office as president expires in March and I would conclude this brief description of the

work of the Institute with a few words of appeal to my fellow members, based on personal and not on official grounds.

I have noticed a certain tendency among some members of the Institute to regard the policy entailing a more or less splendid isolation as being the one best to pursue. I do not believe it. The Institute has its place in the chemical hierarchy and a great and important future will be assured to it if it follows the path of close co-operation with the other chemical bodies. If, on the other hand, the policy of "ploughing the lonely furrow" prevails, it can but lead, in my opinion, to disaster and oblivion. It is also my firm belief that no effective steps towards close co-operation can be taken until the chemical societies are housed under one roof.—JOCELYN F. THORPE.

The Society of Chemical Industry

ON behalf of the Society of Chemical Industry, I desire to offer cordial greetings and seasonable wishes to all connected with chemical pursuits. The Society has, for more than half a century, endeavoured with success to further the progress of chemistry as applied to the general uses of humanity. Its activities are not confined to any one area but are widespread, by means of its numerous sections distributed throughout this country and also in Australia, Canada, and the United States, each of which acts as a rallying point for its members. Its specialised groups not only deal with their chosen subjects, but keep in vital touch with all the sections.

The Society is fortunate to include in its membership many of the leading scientists as well as industrialists, and has created a great fraternity amongst all those to whom chemistry appeals. With this object in view it continually seeks for closer collaboration with other kindred institutions, and is always ready and anxious to further any wise schemes towards the fullest possible amalgamation of the interests of all chemists. The widespread interest in the Journal is indicated by the fact that throughout the chemical world it is affectionately referred to as "Blue Bits."

The annual meeting of the Society, which is to be held next July, in Liverpool, promises to be of special value, and these annual meetings always afford excellent opportunities for chemists and engineers to get in touch with each other. Next July the promised visit to the Institution of Chemical Engineers of the American Institute, many of whose members also belong to our Society, will give special facilities for making friendly contacts with the chemical engineering fraternity.—W. A. S. CALDER.

Imports and Unemployment

By EBEN WALLACE

(Chairman of the Association of British Chemical Manufacturers)

I WANT to remind British manufacturers of the importance of examining imports of chemical products into this country and of studying the possibility of reducing the imports of those products which are already manufactured here or which might be produced in this country as efficiently as in other countries. It may be true that of the total value of chemical imports into this country a considerable volume is due to the import of products which it is not practicable at present to manufacture here.

It is also true that the process of substituting British made chemicals for the imported product may in certain cases be a slow one. This is due to some extent to the fact that the foreign product has established itself in this country over a long period of years and that the foreign manufacturer feels that he has some rights here. Nevertheless, in those cases where a chemical product can be made here as efficiently as abroad, the foreign manufacturer cannot justly deny the major right of the British maker to produce the requirements in his own market, and thus assist in creating employment. In some instances this view is recognised by the foreign manufacturer, but in others, unfortunately, something in the nature of a surgical operation is necessary to convince him of the justice of this view. It is not necessary, perhaps, to state here how that operation might be performed.

Whether we like it or not, economic nationalism has reached such a pitch that the home market becomes increasingly important. Our competitors abroad are concentrating upon a policy of self-sufficiency, and, from the point of view of finding employment for workers in this country, everything possible must be done to increase the home market. It might be argued that production of imports of necessity results in reduction of exports, and that the volume of international trade is usually regarded as the barometer of national prosperity. I suggest, however, that looking at their own industry British chemical manufacturers, by increasing the volume of their home trade, may be better able to extend their export trade.

Commodities in an isolated country are limited by the productive resources of the country and by the inventiveness of its population. In the early days of international trade, imports did not compete with home industries to the extent to which they do to-day. When manufacturing costs per unit did not vary with output, then costs were unaffected by competitive imports, but now that machinery has displaced hand labour, and industry is highly mechanised, a comparatively large output is required to attain the point of maximum return, and competitive imports hinder this.

From the point of view of the British chemical manufacturer, there is a considerable difference between imports of raw materials for further manufacture, and imports of highly finished chemical products, and I would ask British chemical manufacturers to examine import statistics from this point of view. No general rules can be laid down, but each case must be examined on its merits. It may be that the individual manufacturer is willing to allow imports of particular products which he manufactures, in return for some *quid pro quo*—a quota in a particular foreign market, for instance; but the object to achieve would surely be to secure the home market and obtain an adequate share with foreign manufacturers of other consuming markets.

Whereas manufacturers are entitled to expect from the Government stability in the political and monetary factors affecting their business, they can do much for themselves in ensuring stability in negotiations with their foreign competitors.

Imports outside their control may play havoc with the stability of their own manufacturing policy. While the importation of raw materials, and even of manufactured products which cannot be made in this country economically, can be encouraged, the imports of competitive products on which much work has been expended should be discouraged as far as practicable. Much valuable statistical information is available in the report on the Import Duties Act Inquiry (1933) just published, and manufacturers should examine the information laid out for them.

Chemical Industry under the New Parliamentary Regime

By E. F. ARMSTRONG, Ph.D., D.Sc., LL.D., F.R.S.

Dr. E. F. Armstrong, President of the Association of British Chemical Manufacturers.

CONFIDENCE and stability are essential for the conduct of industry. The return of the National Government with a substantial working majority, and presumably an unaltered policy on the all-important question of tariffs, for a further period of years ensures these factors at home and it is now for each industry to formulate plans for its own advancement. The chemical industry, both here and in the United States, has suffered less than many other trades during the prolonged depression. This was to be expected from its scientific character which must lead to better organisation and a greater volume of invention. Our difficulty a few years ago was the vulnerability of the industry owing to the smallness of its individual units which could be singled out separately for attack by the would-be dumper. The formation of Imperial Chemical Industries has made a difference; other weighty factors have been the co-operation of firms brought about by the success of the Association of British Chemical Manufacturers, the Key Industries Duty and the tariffs imposed by the Import Duties Advisory Committee.

The Aim of the Industry

Chemical products in the main are essential in every industry and in every household; the home demand for them, therefore, should be in direct relation to the prosperity of the country. The expected large expenditure on defence, the programme being spread over several years, should increase both the direct demand and that arising from the increased prosperity of the workers. The chemical industry should therefore seek to make in this country all the chemicals required by us at home, and those wanted throughout the Empire also.

The chemical industry has learned during the last few years the value of mutual co-operation and joint action by a number of firms, whilst each has maintained its individuality. It undoubtedly suits our national temperament to work in small units and there is much to be said for the continuance of this traditional practice, provided it is recognised it involves the obligations of co-operation and those other qualities usually associated with good citizenship.

The unit who has his product protected must not seek to buy his chemical raw material abroad for the sake of a small price advantage over that charged for the product by home manufacturers struggling to perfect its production. Chemical products should only be added to the free list in exceptional circumstances. Anthracene is a case in point: the imports have been increasing though it is obviously a product we can make in this country and of which there were formerly large stocks, part of which were destroyed by a fire. This is an opportunity for co-ordination between the producers and potential users of anthracene who can establish how much can be made, at what price it can be profitably produced, what steps can be taken to reduce the cost of production, which in turn depends on a regular demand. Such co-ordination should be simple and none should stand out from it.

The trade associations are essentially a post-war development: to-day they enjoy in large measure the confidence and support of the Government, whereas in early days they received little or no recognition. It is inevitable that in return for the protection which the State is affording industry, some measure of interference must be tolerated. If the State is wise, it will exercise its functions, which one can conceive to be of a variable nature, in large measure through the trade associations; if the industry is wise, it will welcome such method of approach and do all in its power to assist it.

Functions of the Trade Associations

An individual industry may be likened to a regiment in the army, its preparation for mobilisation being a regimental affair and supervised and effected from within by the officers of the regiment. I see no alternative to the regimentation of the chemical industry effected under its own leaders working through the trade association. No chemical firm should have the right to remain outside the organisation, still less should it seek to profit by its success without making its proportionate contribution to it. In the measure of its failure to organise, our industry will be weak and vulnerable; if it succeeds, as it must and will, it will be strong and prosperous.

The conception of organisation covers so much, of the chemical industry as a whole, of its units or groups, of the individual firms large and small. Lord Melchett has done good service during the year by drawing attention to this question, though he goes further than industry is willing to follow him. One of the difficulties is the measure of compulsion which can and should be applied to those who do not act in the way laid down by the industry generally as its policy. Whilst the question of self-advantage, *i.e.*, of profit, sometimes determines this deviation, there may often be exigencies which render the dictated policy obnoxious.

Exaggerated Importance of Selling

One of the consequences of the industrial depression has been the exaggerated importance attached to selling. The lack of sales has been manifest the first thing every morning of the week in the managing director's office of most firms. Every possible means has been devised to increase sales involving all sorts of so-called modern and expensive methods with which our readers are familiar. All firms have done the same to a greater or less degree with the result that Greek has met Greek on the threshold of the buyer's office. I have been told that a laundry of any size to-day receives calls every week from forty different travellers wishing to sell soap. If this is correct, the sales cost to the industry of the few cwt. bought by the laundry must far exceed the prime cost of the soap.

So far, I seem to have preached collectivism to an advanced extent in my prediction as to what will happen under the new government. Such action will not come quickly, but in the measure that it does, our industry will be powerful.

As expressed by Major A. G. Church in a recent letter to "The Times," certain changes in our economic life are upon us and we must be prepared as a nation to consider all

methods—private enterprise, national planning, socialisation—according to the merits of each case and as far as possible in co-operation with those already engaged in the trade or industry concerned. Surely the enlightened will be prepared to help and assist change, irrespective of all abstract theories, when, where and how they are convinced it is necessary. The real thing is to use science, giving to this word the broadest possible meaning, not only in our laboratories and in our works but also in every branch of the business. In this application the chemical industry should obviously be in a position to lead.

It is a matter for regret by all that Sir Christopher Clayton has not sought re-election and that he will no longer represent the chemical industry in the new Parliament. His wise and temperate counsel will be greatly missed.

Some Interesting Plants

The heavy industries have continued to progress in this country because they have not been afraid to rebuild their plants. Their problems are essentially the handling of large quantities, of transport to and within the works: the lowest priced steam and electricity are essential, involving heat recovery and attention to details in design. Research has shown how to attain the maximum yield of product of satisfactory and regular quality. An outlet is usually found for the by-products of the operation so that there is a minimum of waste. The plants of Imperial Chemical Industries for the manufacture of soda ash and caustic soda are outstanding examples of the foregoing considerations. A unique item is a plant at the works of one of the Lever Brothers companies, for the continuous manufacture of caustic soda from sodium carbonate and calcium oxide, with continuous conversion of the calcium carbonate formed back into lime in step with the first process. The lime thus serves over and over again as carrier of the "caustic hydroxyl" group.

Sulphuric acid is made efficiently on a variety of scales by the catalytic process, ingenuity being displayed in the utilisation of various sources of sulphur for this purpose which would otherwise have been waste. The utilisation of the waste sulphur gases is also likely to come to the fore: this would make us independent of imported sulphur. Hydrochloric acid is properly made by combining hydrogen and chlorine, and no longer from salt and sulphuric acid. Nitric acid originates from synthetic ammonia by catalytic oxidation. All three acids are to-day made in plants which might be described as applied physical chemistry characterised by being continuous, largely mechanical and essentially clean. Chlorine is made by electrolysis, and with it caustic soda, in cells which it is ever sought to improve. A by-product of the electrolytic factory is hydrogen, and heavy water, the latest fashionable toy of science, accumulates in the cells.

The Carbonising Industries

The carbonising industries have, with a few notable exceptions, been wholly in the hands of engineers so that they have not developed as chemical manufactures. It might be suggested that this has been to the detriment of their progress and their competitive power with newer developments. There appears to be something innately conservative and reactionary about coal and all connected with it. Gas is the product of one carbonising industry, metallurgical coke of the second industry, the chemical by-products have been sold for others to develop. It is only now that a serious attempt is beginning to up-grade the products of coal.

A new stimulus has been provided by the production of oil—motor fuel—either direct from coal by hydrogenation or from tar. Whatever may be the present economics of this venture as regards the cost of its petrol in relation to imported oil, it is certain that it will provide much information as to the liquid products which can be obtained from British black coal. It may give a lead to the gas industry to hydrogenate their tar which it is believed can be done on the small scale in plant such as that successfully worked out by the Fuel Research Board, though others claim that such hydrogenation can only be done on the largest scale. Home produced benzol scrubbed out of coke oven or town's gas has come to the rescue financially of the former industry, whilst stripping is increasingly practised by the gas industry.

Having no natural oil, Britain can only base a refining industry on imported crude, and so far there has been very little refining done in this country. In America the oil industry is becoming increasingly chemical under economic stress: the low prices obtained for crude and petrol make imperative the utilisation of natural gases and all other petroleum products to the best advantage. An immense volume of research is resulting in the evolution of a number of chemical products from petroleum products and of new processes involving, for example, the use of solvents in refining. In one high-quality lubricating oil is obtained by simultaneous extraction in counter current with two solvents, *viz.*, liquid propane and cresylic acid, in another such oils are dewaxed with acetone.

Progress of Allied Industries

One of the most satisfactory features of the recrudescence of British industry has been the marked development of the chemical industries, of which perhaps the importance to the nation and the community is still only partially realised. Whilst some sections of industry are obviously chemical, *i.e.*, those connected with the making of acids and alkalis, of dyes, of drugs and fine chemicals, there are many others which are just as chemical in their operations and depend on chemical research, chemical engineering and scientific operation for their success. Glues, paints, solvents, cement, tanning, the fat industry, metals, cellulose products and paper, rubber, explosives, glass, bleaching, dyeing and printing in the textile industry, artificial silk, wood, coal and shale distillation, brewing and distilling, and even petroleum refining, are all in reality chemical industries although they may have their special problems peculiar to themselves and their raw material. It may be claimed that these industries are successful in the measure that they become chemical.

The chemical industry, including the organic chemical industry, is progressing technically as the result of the wider application of what is termed "physical chemistry" and when translated into practice becomes chemical engineering. In older days chemical processes were primarily batch processes, the laboratory experiments performed in glass containers or crucibles were translated on the works scale to metal vessels and retorts. To-day the urge is towards continuous processes and in so far as these are successful, chemical products become available in greater quantities, at materially lower prices and often of higher purity. This is particularly true of the solvent industry and of refining and distillation as well as of heavy chemicals, and it may be forecasted that progress in the next decade will largely depend on the success in transferring batch processes to continuous operation.

Finding New Uses

The increased production resulting from continuous operation brings with it the need for an increased outlet for the product which can only be met as a rule by finding new uses. The urge to find these is very great in relation to organic substances to-day and all sorts of out of the way products are being studied and tested in every possible manner, it being assumed, and rightly, that they can be made in quantity if desired. So far, America has taken the lead in studying these new applications, no doubt because of the national willingness of the American to try something new because it is new and to finance it, whereas in Britain our conservatism makes it difficult to find the money for new inventions, except at exorbitant rates, the profit going into the hands of financiers who take no further interest in the success or failure of the venture. It is as well to stress this condition as in our belief it affords an explanation why British chemists are seldom associated with novelties: it is only when they have been worked out abroad and proven that they are adopted here at the cost of a royalty to the foreigner.

Conditions in the Heavy Chemical Industry in 1935

By P. PARRISH, F.I.C., M.I.Chem.E., M.I.Gas E., F.I.A.A.

Mr. P. Parrish, Chief Chemist, South Metropolitan Gas Co.

TRADE in the heavy chemical industry in 1935 has improved materially, as contrasted with the last two years. Now that the country has elected a new government, and reasonable political stability can be expected, it is hoped that still further consolidation of British trade will ensue.

The death of Dr. Carl Duisberg, the late chairman of the I. G. Farbenindustrie, occurred in May last. He combined in a peculiar degree genius with broad knowledge and experience, organising and constructive ability, and drive. He grew in culture and wisdom with the years. Dr. Duisberg will be remembered for the development of the Leverkusen works, and for launching his idea of a comprehensive chemical trust—now the I.G. Those who have had the privilege of visiting Leverkusen, as the author has, and have seen the attractive layout of the works, its ordered arrangement and charm, who have inspected the plant for utilisation of anhydrite in the manufacture of oleum, and the many other processes, cannot fail to be concerned at the passing of so distinguished a man.

Synthetic Ammonia Industry

Most of the nations of the world have established a synthetic ammonia industry. This has been done largely in the interests of national security. It was impossible to expect that all these synthetic ammonia plants would be able to work at full output. Productive capacity outstripped demand several years ago, and the existence of an international nitrogen cartel became a necessity. It is not an easy matter to adjust the world's demand for nitrogenous fertilisers to the existing super-abundant possibilities of supply. It will become less easy as time elapses, because further production of synthetic ammonia is projected in Russia and the Far East.

Little change has occurred in the technique of the synthesis of ammonia. Efforts are now directed to increasing efficiency, and to the production of catalysts that are less susceptible to poisoning.

Distinct service has been rendered by THE CHEMICAL AGE, by publishing a series of articles on the economics of the synthetic production of ammonia. These contributions must have proved of value to many engaged in chemical engineering. They afford data about quantities and costs, and reveal that the arc process was economically impossible, because of power cost; that the cyanamide process, although more favourable, was still impossible in this country, but that the Haber process would compete with imported Chilean nitrate, and with other fixation processes, using cheap water power.

Ammonium Sulphate Crystals

G. Berkhoff has investigated the influence of physical conditions (temperature, concentration, etc.) and the presence of impurities, on the crystal size and habit of ammonium sulphate crystals from aqueous solutions. To obtain large crystals, iron, aluminium and chromium should first be precipitated as phosphates, and the solution should be kept as uniform as possible during crystallisation. The same idea appears to have occupied the attention of the chemical staff of the States-Mines in Limburg. At this works, arsenical sulphuric acid is used for combination with the synthetic ammonia. By the addition of a phosphate or phosphoric acid to the mixture, to precipitate the impurities, and by maintaining the acidity at 1.5 per cent. H_2SO_4, it is said that satisfactory crystal size can be obtained.

The author has never found any necessity for the precipitation of impurities arising from the acid, whether arsenical or otherwise, when synthetic or by-product ammonia has been used. Provided certain fundamental considerations are observed, affecting design of saturator and control of conditions, satisfactory crystal size can always be obtained. Certain impurities are desirable.

Any successful method of hydrogenation involves the economic production of hydrogen. Hydrogen can be produced by electrolysis of water (the Knowles column cell is becoming increasingly popular), by the water-gas reaction, and by the liquefaction of coke-oven gas. Latterly, a method involving the passage of steam and methane over a catalyst consisting of finely-divided alumina or rare earth oxide, impregnated with nickel or cobalt, has been used with success by the Standard Oil Development Co. The products resulting from the above reaction are carbon monoxide and hydrogen, which are subsequently passed with more steam over an iron oxide catalyst, to produce carbon dioxide and hydrogen, from which the carbon dioxide is removed by suitable means.

Oil Production and Hydrogenation

The Billingham plant, which took eighteen months to build, is the first in the world to make petrol on a commercial scale by the hydrogenation of bituminous coal. It produces only four per cent. of the country's consumption of petrol, and employs nearly four thousand tons of coal per day. In the hydrogenation process, coal (coal-in-oil "paste") is treated under pressure with hydrogen, so that solid coal is transformed nearly quantitatively into petrol and gaseous hydrocarbons. The yield of petrol is between 60 and 70 per cent. by weight.

Low-temperature tar and creosote oil, when hydrogenated into petrol, give a yield of between 80 and 90 per cent. So long as the home-produced spirit enjoys the full advantage of eightpence per gal. over imported spirit, the economics of the process may be assured. But the position would be different if, under the British Hydrocarbon Oils Production Act, preference were reduced to the minimum of fourpence per gal.

Having regard to the marked suitability of low-temperature tar (coal oil) for hydrogenation purposes, one would have expected low-temperature carbonising processes to become increasingly popular. If the possibilities of the least-developed aspect of this industry (the gaseous product) had been suitably explored, there is little doubt that low-temperature processes would have gained growing favour with the

public. As it is, it would seem that there are wonderful prospects ahead for this industry. Many cities and towns are determined that they shall be rid of the smoke nuisance. The collaboration of existing gas undertakings would appear an indispensable step in connection with such development.

The output from the Sicilian sulphur mines is now about 250,000 tons per annum, whereas the American production in 1933 was about one and a half million tons. Agreements were made, in 1934, between the Sicilian and Central Italian (Montecatini) group on the one hand, and between the Sicilian and American producers on the other, by which some degree of price stabilisation was effected. The Italian Government has lent financial aid, by a subsidy of ten million lire.

Recovery of Sulphur

Last year the various processes in which the gas and coke-oven industries were interested, for the recovery of sulphur, were indicated at some length. If one quarter of the average of about one per cent. of sulphur contained in the 1,200 million tons of coal annually consumed were recovered, more than sufficient sulphur to meet the present world demands (three million tons) would be made. The Billingham process, which has recently been established on a practical scale, provides for the reduction of sulphur dioxide by coke at a high temperature. Indeed, it depends on a similar reaction to that used in the Orkla (Norwegian) process for recovering sulphur from pyrites. With metallurgical gases, however, the difficulties of concentrating the gases sufficiently before reduction, and of eliminating the undesired carbon dioxide and carbonyl sulphide, have been considerable.

Russia is known to have large quantities of carbonaceous pyrites, probably similar to the coal brasses that arise in the Nottingham mining district and other areas. Coal brasses have been burnt in this country for the production of sulphuric acid for the last thirty years, and little disability has been occasioned. The I. G. Farbenindustrie is now producing at least 5,000 tons of sulphur per annum, largely from anhydrite, by treatment with clay and coke—a method developed during the war.

Sulphuric Acid

Last year, reference was made to the production of sulphuric acid by pressure nitration synthesis, and it was remarked that it was essentially a chemical engineering problem, within the ambit of practical realisation. It is known that Professor Ernst Berl has been conducting further work on this process, but no announcement has been forthcoming that it has reached a practical stage. Indeed, doubt concerning the feasibility of the process, as also that of Samarski and Ziberlich, has been expressed in several quarters. Each process is faced with rapid dissipation of the enormous exothermic heat of reaction. It is here that the major difficulties reside. One tower chamber system has been tried in the past, with unsuccessful results. Meanwhile, the intensive systems which obtain in this country are the Gaillard-Parrish and the Mills-Packard. Both have been adopted on an extensive scale, and both possess the merit that they are capable of easy control.

Turbo dispersers have been applied to several Mills-Packard units during the current year, with eminently satisfactory results. The dispersion of chamber acid of suitable strength has been rendered foolproof by the adoption of improvements in the design of turbo dispersers, and the operating costs are now practically negligible, because of the adoption of an inexpensive and automatic means of elevating the acid.

The Gaillard-Parrish System

The Gaillard-Parrish system is becoming increasingly flexible. It can be applied to existing rectangular chamber plants, as at Riga, where production has been increased by fifty per cent., at comparatively little expense. The system can be still further intensified, by lining the tower chambers with Obsidianite toggle bricks, and by dispersing a suitable nitrose. Gaillard-Parrish plants can be erected more cheaply than formerly, by using a pitch pine skeleton framework, with light steel suspension, as illustrated in Fig. 1. Such a combination of chambers can be enclosed in a special way, at small cost, the stress on the lead wings removed, and a rapid air current established for external cooling. Internal cooling is effected by irrigating the lead walls with the cooled acid. No other system appears to offer such flexibility.

A new type of "Vitreosil" concentrator, adapted for firing directly with gas or oil burners, or by combustion products

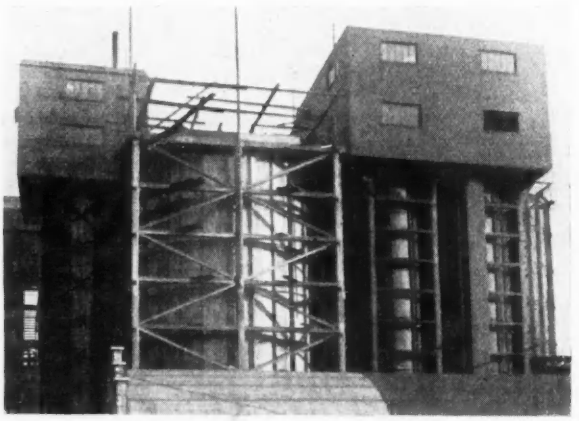


Fig. 1.—Gaillard-Parrish Tower Chamber, pitch pine frame, with steel suspension.

from an external source, has been described by B. Moore and T. H. Barton, experimental results being discussed. Performance figures show that the concentrator has a high efficiency to utilise available heat, is reliable and flexible, and involves small fluid resistance. The fuel-less concentrator to which reference was made in a previous review still continues to operate satisfactorily.[1] Burning spent oxide at the rate of 8 tons per day, the sensible heat is such as to concentrate 2 to 2½ tons of sulphuric acid per day, raising this from 80 per cent. to 93½ per cent. Any discolouration can be easily removed by the application of a suitable oxidising agent, and the acid can be fortified to 95 per cent.—the usual strength at which C.O.V. is sold—by the addition of a small quantity of oleum.

Catalytic Oxidation

Investigations into the mechanism of the catalytic oxidation of SO_2 have revealed certain important factors. Salts such as $CuSO_4$, $Fe_2(SO_4)_3$ and $BaCl_2$ enhance the catalytic effect of V_2O_5 differently, according to the carrier used. Both stability and efficiency are significantly affected.[1] The activities of vanadic acid and certain vanadates have been compared, and it has been found that the presence of sodium vanadate is responsible for the comparatively high activity of technical catalysts.[2] Silver vanadate on a silica gel carrier has been found to give unimpaired conversion in the presence of As_2O_3.[3]

During the year the Chief Alkali Works Inspector intimated that the method hitherto obtaining for determining the total acidity of chamber plant escapes by absorption in hydrogen peroxide was unsatisfactory, in that it did not include all the acidity due to oxides of nitrogen. Investigations in the Chief Inspector's laboratory have led to the development of a modified test. Results have been published, show-

(1) "J. Appl. Chem. Russ.", 1934, 7, 725. B.146.
(2) "Z. Electrochem.", 1935, 41, 589. B.898.
(3) "J. Soc. Chem. Ind. Japan," 1935, 38, 80. B.492.

ing the original short test, using bellows, in relation to the new method (bottle test), to be as follows :—

ACIDITIES, EXPRESSED AS GRAINS SO_3 PER CU. FT.

0.9 – 1.4 – 1.4 – 2.8 – 0.20 – 0.22 –
1.8 – 2.2 – 2.6 – 4.7 – 0.44 – 0.66

There can be no doubt that what the Chief Alkali Works Inspector has in view is a step in the right direction. The existing Act provides for the inclusion of all the acid gases, in the determination of escapes, but the method hitherto employed has failed to arrest all the absorbable nitrogen oxides. If the Gay Lussac towers of sulphuric acid plants are adequately designed, and the packing material is maintained clean, and channelling avoided, it should be possible to obviate coloured discharges. The aim, obviously, of the Chief Inspector is to obviate the emission of oxides of nitrogen, and the result, from the sulphuric acid manufacturer's point of view, will be an economy of nitre consumption. There is need for a method for continuously recording the total acid gases discharged from sulphuric acid plants. Spot tests do not necessarily afford a true criterion of the twenty-four hours' operation.

By-Product Ammonia

That the by-product ammonia problem will be solved by the production of concentrated gas liquor, and its treatment at centrally-situated chemical works, is not now doubted. 19 to 20 per cent. ammonia by weight is to be produced.

Processes for the production of ammonium bicarbonate have been developed, but pending results of plot experiments, as to the suitability of ammonium bicarbonate contrasted with sulphate of ammonia, action cannot very well be taken.

The treatment of effluent liquor from concentrated gas liquor plants is a simple matter, and its effects on domestic sewage have been investigated by Dr. Key and his staff, who are attached to the Liquor Effluents and Ammonia Committee of the Institution of Gas Engineers.

Soda Ash and Caustic Soda

The ammonia-soda industry continues to grow. Three new plants have been erected in America, and several other plants are projected. In connection with the Australian project, salt, the principal raw material, will be obtained by solar evaporation of sea water. In view of the large area of evaporating surfaces required, obviously, some time must elapse before these can be prepared and put into operation. Innovations are few, although several refinements of detail have been incorporated. Attention is directed to the production of a higher concentration of CO_2 in the kiln gases, and to the avoidance of unnecessary dilution of the ammoniacal mother liquors. Similarly, the removal of iron compounds from the liquors undergoing carbonation in the towers and a reduction of temperature in the coolers attached to the towers is receiving attention. Incrustations are a source of nuisance.

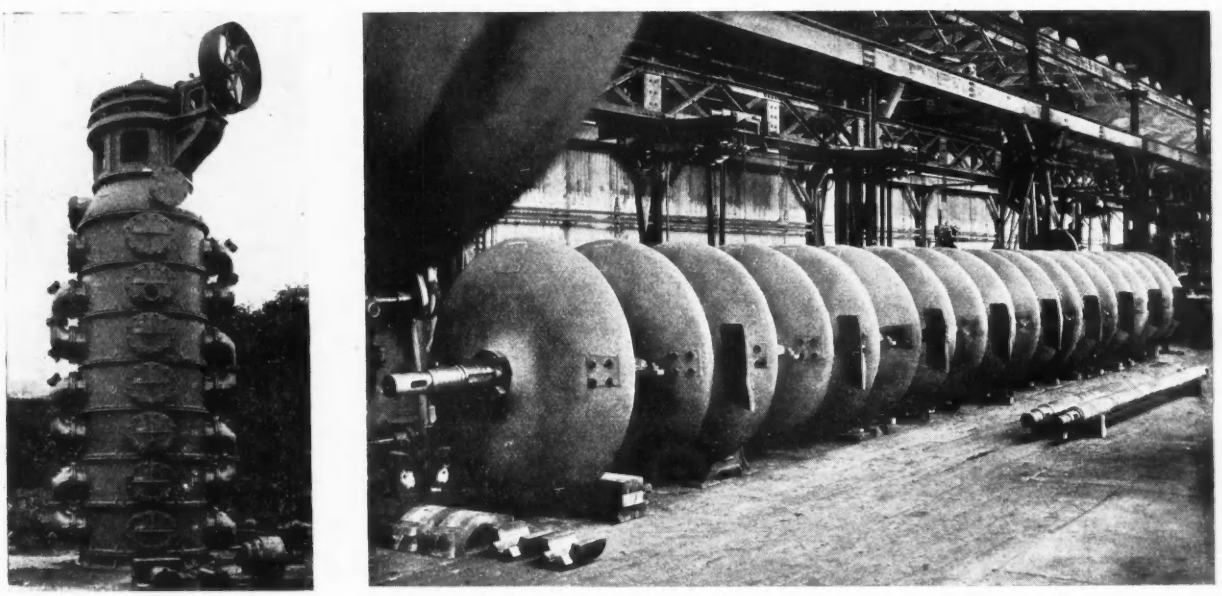


Fig. 2.—Mechanically-Agitated Distillation Unit, showing (right) the full Agitator Shaft with hoods.

Experience of the operation of concentrated gas liquor plants, and of concentrated gas liquor, has increased during the last twelve months. One can now with reasonable accuracy determine, from the characteristics of the gas liquor, whether concentrated gas liquor containing (a) 15 per cent. of ammonia by weight or (b) 19-20 per cent. of ammonia by weight can be made without decarbonation. Indeed, it is now becoming known that a gas liquor is an index of the methods practised in the carbonisation of coal.

Where straight coal gas is manufactured, and the CO_2 content of the gas is maintained at about 2 to 2½ per cent., the CO_2 :ammonia ratio in the gas liquor is such that concentrated gas liquor of about 19 to 20 per cent. by weight can be manufactured without decarbonation. Where steaming occurs, and the CO_2 content of the crude gas reaches five per cent. or even more, then the characteristics of the gas liquor are such that decarbonation (a fairly expensive operation) is necessary, if concentrated gas liquor containing

Where synthetic ammonia is employed for ammoniating the brine solution, it is necessary to use either sodium sulphide or to "sulphide" the solution of ammonium hydrate prior to use. Such a step is necessary, in order to avoid corrosion of the expensive cast iron distillation units and other parts. At least one firm in England has been responsible for the fabrication of distillation units (mechanically agitated type) for the ammonia-soda industry. Fig. 2 gives an idea of the nature and dimensions of such plant.

Cheap Hydrogen Sulphide

How to generate hydrogen sulphide cheaply, for "sulphiding" the solution of synthetic ammonia, is a distinct problem with some works. In this connection, if steam is passed through monosulphide of iron (FeS), at temperatures ranging from 600 to 1,000° C., the products of reaction are chiefly

ferric oxide and hydrogen sulphide; ferrous oxide, hydrogen, sulphur dioxide and sulphur occur in minor quantities. The reactions are reversible, and a higher percentage conversion can be obtained, with higher relative concentration of steam.

Attempts have been made in Russia and elsewhere to utilise sodium sulphate in the production of sulphur and soda ash, but nothing successful appears to have been evolved. Improved methods have been developed for the recovery of ammonium chloride from Solvay liquors, which contain sodium chloride, ammonium carbonate and ammonium chloride. Calcium chloride is introduced, to precipitate the carbonate, and subsequently carbon dioxide is bubbled into the solution, to precipitate the calcium. The free ammonia is removed by steam, and, finally, the solution is evaporated to a stage just above that at which sodium chloride separates, when it is cooled for the crystallisation of the ammonium chloride.

Cerini Dialysers

Cerini dialysers have been adopted at certain viscose rayon plants, both in Europe and in the United States. It is said that these dialysers recover ninety per cent. of caustic soda in the liquor from the final pressing of the pulp in the steeping operation. The process functions on the principle of osmotic exchange, between solutions of different concentrations when separated, by a semi-permeable membrane. The impure solution enters the bottom of the tank with 16 per cent. of caustic soda, 4 per cent. of carbonates, and 2 per cent. of organic matter. Water enters the top of the diaphragm, becoming progressively charged with caustic soda, while the impure solution is progressively depleted of the caustic soda. The overflow of the tank possesses a caustic soda concentration adequate to keep the hemi-cellulose in solution. The active diaphragm area is about 300 square metres per unit, each cell being 3 metres long, 1 metre high, and $2\frac{1}{2}$ cm. wide.

Friable caustic soda can be manufactured by the addition of heavy motor oil or paraffin to the drum in which the molten caustic soda is cast for shipment. When so treated, it is found that the caustic soda crystallises in a fibrous form, which is readily susceptible to crushing. This process is covered by U.S. Pat. 1,946,863.

Sodium Chlorate Manufacture

There appears to be an increasing demand for sodium chlorate throughout the world. This product can be manufactured electrolytically, but, obviously, cheap power is a desideratum, as six parts of salt are decomposed in the production of one part of sodium chlorate. This salt is used for the extermination of weeds by spraying a solution on the plants. In doing this, the solution is apt to fall on the clothing of the man undertaking the spraying. The water evaporates rapidly, leaving the chlorate distributed within the fibres of the clothing, and in the closest contact. The cloth is then prone to burst into flames, so soon as a spark, or blow, or friction, is applied at one spot. Indeed, it is said that a person with clothing contaminated with chlorate resembles a human match. Methods are now known by which it is possible to render sodium chlorate non-inflammable, and it would appear that such a product should be used as a weed-killer.

The purification of calcium chloride can be effected by dissolving in a minimum of hot water, crude calcium chlorate, and cooling to $-60°$, when crystals of pure $Ca(ClO_3)_2.2H_2O$ are formed, and can be removed and centrifuged.

Ferric sulphate is finding increasing use in the purification of water, and as a coagulant for sewage. It has the advantage—common to many ferric salts—of coagulating on the alkaline side, where aluminium sulphate forms soluble compounds. The tendency in modern purification latterly has been to depart from acid or neutral water, and its resulting corrosion. For this reason, aluminium sulphate *alone* as a coagulant is less in favour than formerly. The development of a cheap iron coagulant will stimulate the development of chemical sewage treatment.

Ammoniation of calcium superphosphate in the United States is now largely a commercial practice, which has been responsible for increased sales of liquor ammonia. Incidentally, it is reported that ammoniation has resulted in an improved product. The addition of sulphur to finely-ground phosphate rock, under special conditions, has been found to be advantageous. Lipman, McLean and Lint have undertaken a good deal of work in the rendering of mineral phosphates more available by composting them with sulphur. The activity of micro-organisms causes oxidation of the sulphur, and the formation of soluble acid phosphates by interaction of mineral phosphate and the sulphuric acid produced by the organisms. The sulphur-oxidising organism, *Thiobacillus thiooxidans,* was able, in pure culture, to increase the water-soluble P_2O_5 from 46 parts to 207 parts per 100,000 in fifteen days. The reactions which occur, according to Joffe, are:—

(1) $2S + 2H_2O + 3O_2 = 2H_2SO_4$.
(2) $Ca_3(PO_4)_2 + H_2SO_4 + 2H_2O = Ca_2H_2(PO_4)_2 + CaSO_4.2H_2O$.
(3) $Ca_2H_2(PO_4)_2 + H_2SO_4 + 2H_2O = CaH_4(PO_4)_2 + CaSO_4.2H_2O$

Sulfurophosphate—a fertiliser of growing popularity in this country—is a product based on the foregoing conceptions, but contains calcium carbonate in a finely ground condition, in order to afford an additional property. This product, when ammoniated in a special way, has proved to be an excellent compound fertiliser, for which there is an increasing demand.

The tendency in the superphosphate industry is towards greater consolidation. Most of the smaller superphosphate manufacturers have now been absorbed either by the Anglo-Continental Guano Works, Ltd., or Fison, Packard and Prentice, Ltd., or their sister undertaking, the National Fertilisers, Ltd. The two processes which are now largely used for the manufacture of calcium superphosphate are the Broadfield and the Oberphos. Each claims distinctive merits. There can be no doubt that the quality of calcium superphosphate has improved during the last decade, and that a granular fertiliser is now the order of the day.

The use of chemical fertilisers—N.P.K. mixtures—of varying concentrations, is gradually increasing. These all-in fertilisers are invariably prepared in excellent physical condition, and admit of easy application, whether by drilling, or scattering by hand.

Essential Oil Industry

Conditions in France

THERE was little change in the perfumery-materials trade of the Grasse area in the third quarter of 1935. Shipments to the Uuited States decreased nearly £12.500, compared with that of tre preceding year. Business with British markets was only fair, and trade with Germany continued to be held to a relatively small percentage of the volume possible by financial and other restrictions. Difficulties in connection with payments interfered to some extent with improved trade relations with Spain.

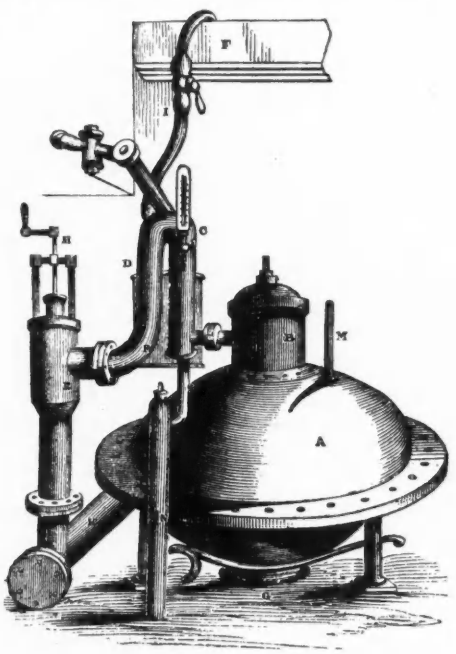
The domestic perfumery material market continued quiet, reflecting the reduced demand for French perfumes. An indication of the importance of Franco-Italian trade in perfumery materials is shown by customs statistics of the port of Marseilles, where in the first nine months of this year 196,240 lb. of lemon, sweet orange, bergamot, and tangerine oils were received from Italy, and 38,500 lb. of perfumery materials were shipped to that country. A proposal to establish a Government credit of 6,000,000 to 8,000,000 francs for the relief of the Grasse cultivators has been made by a member of the Chamber of Deputies representing that region. It was estimated that disbursements for flower and plant supplies taken by the factories during 1935 would not exceed 10,000,000 francs, or considerably less than one-third the amount paid to cultivators in 1930, and less than one-fourth the amount distributed in 1927, 1928 and 1929.

Chemical Engineering in Retrospect and Prospect

By HUGH GRIFFITHS, B.Sc., A.R.C.S.

CHEMICAL engineering is now recognised all over the world as an important subject. After being regarded with a certain suspicion by both chemists and engineers, the chemical engineer has now become respectable, and institutions have been formed to maintain his professional status; in some quarters he is even regarded with a certain reverence. The idea seems to prevail that chemical engineering is something quite new, and it is therefore good to look back to ascertain how the successful manufacturers of the past built their plants. It must be admitted that many industries had reached a very high pitch of efficiency before any great bulk of systematic chemical engineering knowledge was generally available. A good illustrated history of chemical plant would prove a revelation to those who ignore the achievements of the pioneers, but unfortunately no such treatise exists.

In browsing through old books one is struck by the resemblance in the apparatus described to that illustrated in trade catalogues at the present time. The student will find interest in looking at such books as Walter's "Erfahrungen eines



The Vacuum Pan originally designed by Howard over a hundred years ago.

Betriebsleiters"; Davis's "Chemical Engineering"; and Muspratt's "Chemistry." Filter presses, vacuum pans, mixing machinery, grinding mills and other equipment are shown which do not greatly differ in principle from modern designs. The vacuum pan, as originally designed by Howard over 100 years ago, is of exceptional interest. A study of the accompanying illustration will show that he must have understood quite clearly all the fundamental principles, and the design is, even judged in the light of present-day knowledge, quite sound. Howard, who was also the discoverer of mercury fulminate, must have been a chemical engineer.

Whilst to-day the thermodynamic principles governing evaporation are well understood, and the principle of the reversed heat engine is extensively applied, particularly in dealing with sensitive materials, it should be borne in mind that Pelletan, nearly 100 years ago, proposed a system employing jet thermo-compressors, and trials were reported showing an evaporation of 2.3 kg. per kg. of live steam. The diagram reproduced shows Pelletan's scheme.

Some of the illustrations in the next page show modern developments of the vapour compression principle as applied to evaporation and crystallisation. The principle is also applied to heat economy problems in connection with solvent recovery and benzole extraction plants.

In spite of the striking attainments of the pioneers, of whom only two have been mentioned, the physical design of plant, until comparatively recent years, was dependent on direct experience. The treatise of Davis, to which reference has been made, was probably the first attempt to deal with chemical engineering in a systematic way. The state of theoretical knowledge in some specialised directions and the wonderful efforts which were made to attack industrial problems scientifically may be seen from the works of Sorel, and Barbet, on distillation, etc., Hurter on absorption of gases, Weiss on condensation, and Hausbrand on evaporation, drying and distillation. It is probable that many of these writers were indebted to the work of Péclet, whose "Traité de la Chaleur" provided a magnificent summary of the available knowledge of the thermal principles applicable to chemical engineering, known at the time.

The marked success of chemical manufacturing firms

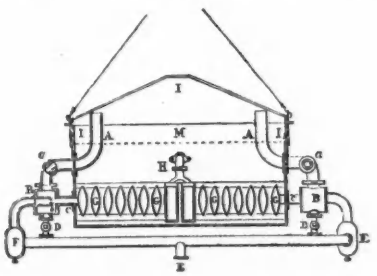


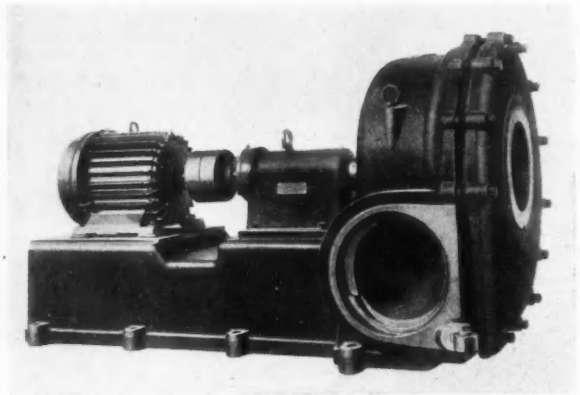
Diagram of Pelletan's scheme for evaporation, nearly a hundred years ago.

established in the days when plant design was empirical sometimes creates misunderstandings. A young chemical engineer recently complained to his managing director that most of the manufacturing equipment in the works was out of date. The reply was: "My grandfather started this business many years ago with no more plant than a few old tubs and a stick and made an enormous amount of money." Another manufacturer, in discussing the possibilities of scientific plant design, said "We have now been manufacturing chemicals for about 70 years and have found that it has always been necessary to build a plant three times before it is found satisfactory."

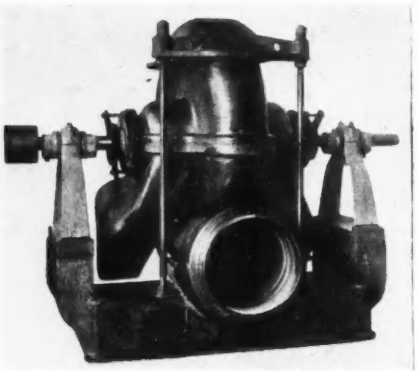
It is true that many successful firms have developed complicated and highly efficient plants by empirical methods, but an examination of the history of these concerns will show that either they started in a small way, or they were free from severe competition for a long period. In consequence, the cost of "gaining experience" was not too great. To-day, in practically every industry, even when new manufacturing processes have to be exploited, the problem facing the chemical engineer is a most difficult one. There is neither time nor money to "gain experience" with tubs and sticks, and plants are normally of such large capacity as to make "building three times" quite impossible for financial reasons. The present requirement in chemical engineering is therefore that of accuracy both in design and precalculation of output and operating cost. In respect of mechanical and practical design, the necessity for building unit plants of large capacity with minimum labour costs has been a determining factor.

To-day we have available better constructional materials: alloys resisting corrosion and high temperature, special acid-resisting stoneware of improved mechanical properties, synthetic resin components, rubber and ebonite linings. The development of welding processes makes it possible for us to obtain cheaply special vessels of large size in all ordinary metals. Some of the illustrations show examples of recent designs in acid-resisting stoneware. The modern constructions of fans and pumps are built up from accurately ground parts which are produced by repetition methods and are interchangeable. The new fans are armoured in metal and compare favourably in performance and strength with ordinary fans for handling non-corrosive gases.

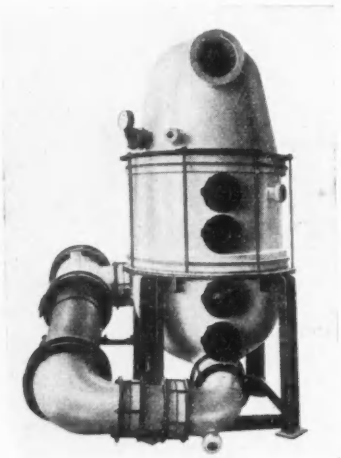
Much more important, however, is the fact that our know-



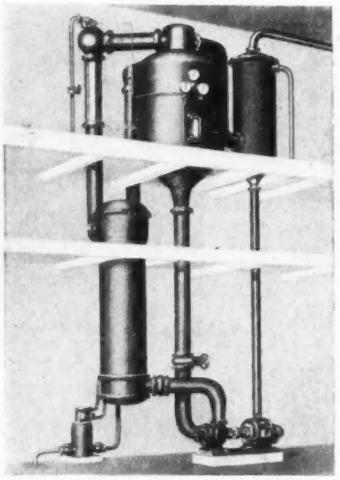
New design of Armoured Fan for Corrosive Gases, direct coupled to motor. (Deutsche Ton- and Steinzeugwerke, A.G.)



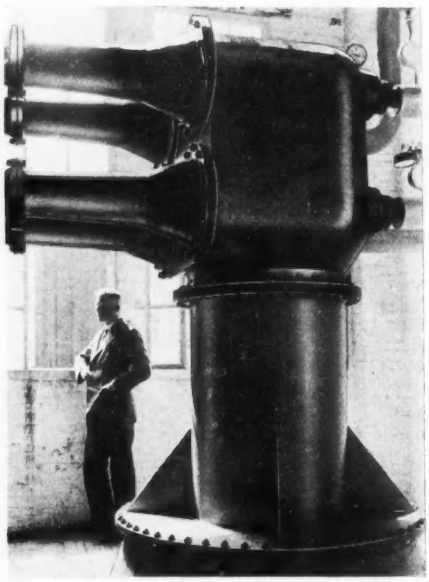
Older type of Fan for Corrosive Gases. (Deutsche Ton- and Steinzeugwerke, A.G.)



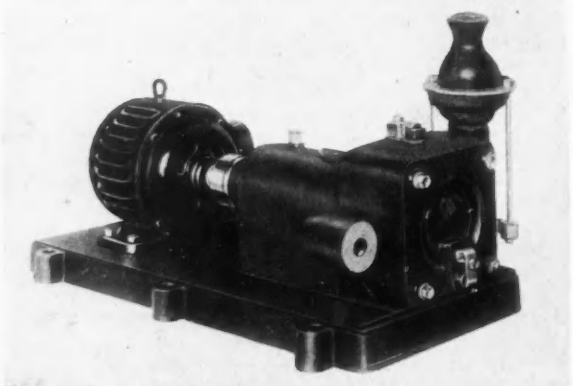
Stoneware Vacuum Evaporator with external circulation heater. (Deutsche Ton- and Steinzeugwerke, A.G.)



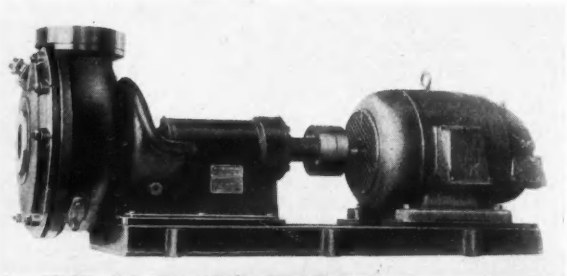
Lurgi System Forced Circulation Evaporator with thermo-compressor for viscous sensitive materials.



Thermo-Compressors employed in a Crystallisation Plant for dealing with over 30 tons of liquor per hour. (Metallgesellschaft system.)



Modern Stoneware Centrifugal Pump, block type, with interchangeable parts. (Deutsche Ton- and Steinzeugwerke, A.G.)



Armoured Stoneware "Deuton" Centrifugal Pump.

ledge of constructional materials is becoming quantitative. Not very many years ago it was, for example, customary in calculating the strength of a structural member to compare the applied stress with that at which the material would fail, and to call the ratio a factor of safety. Modern research has disclosed the fact that such factors of safety were merely factors of ignorance. The investigations of fatigue, corrosion fatigue, creep at high temperatures, have now put us in the position of knowing more accurately the nature of safety margins necessary under special conditions. The successful development of processes requiring high pressures and temperatures, *e.g.*, ammonia synthesis and hydrogenation of coal and tars, is dependent upon precise knowledge of this kind.

The calculation of plant performance is one of the most important branches of chemical engineering. The old guessing or trial methods are unsatisfactory for modern requirements, and the prediction of output necessitates a scientific analysis into the physical factors influencing output. Even when some similar apparatus may be available, so that data can be collected, it is more often than not necessary to make a physical analysis of the problems to correlate the data in a satisfactory way.

Fluid Flow and Heat Transfer

Unfortunately the physical phenomena are frequently of such a complex character that direct theoretical attack is impossible. In the case of problems in fluid flow and heat transfer, for example, theoretical analysis is possible and reasonably fruitful so long as stream line flow be maintained. In practice, however, turbulent flow conditions are usual and theoretical analysis is unavailing. Fortunately in cases of this kind we can employ new methods of correlating data such that the influence of varying conditions can be followed with sufficient accuracy. These methods of correlation also enable us to transfer our experience from observations in one set of conditions to another with useful accuracy. In problems involving fluid flow, for example, it is important to know how resistance to flow will alter if the viscosity, density of the fluid, the velocity or pipe diameter be changed Instead of attempting to guess, or to work with inadequate theories, we are now able, by plotting dimensionless groups, such as the Reynolds Criterion, to express the essential data in a practical and useable form which is free from false assumptions or risk of practical blunders. In the case of heat transfer problems, the use of similar dimension-less groups has also been of great value.

Whilst, as previously stated, in many types of installation only very slight advances in essential principles have been made in recent years, the designs have now been more accurately proportioned as a result of improved methods of applying physical principles, and it is now possible to calculate in advance with considerable accuracy the ultimate performance which will be obtained.

Increase in Size of Plant Units

The increase in size of plant units has not merely made it necessary to design much more carefully in order to avoid expensive mistakes in the proportions and sizes chosen, but mass production against competition has stimulated the practice of calculating the production costs in advance with the closest possible accuracy. Such calculations naturally lead to the calculation of a materials and energy balance which will show clearly whether any recoverable losses occur. Such calculations also show up clearly the costs of heat and mechanical energy. The importance of regarding heat as a raw material of manufacture has been insisted upon for years, but competitive conditions have produced an entirely new mental attitude: whilst all manufacturers have appreciated that heat costs money, the present tendency is to calculate out carefully the thermal economy attainable by elaborations in plant in relation to their capital cost, and in consequence the thermal efficiency of chemical plants may be expected to rise considerably.

The modern tendency to favour continuously-operating processes is not always simply directed towards mass production. From a physical point of view it is usually much less laborious to design a continuous plant with accuracy than an intermittent one, and operating conditions may be much more easily controlled. Thus, for example, it is very nearly impossible to secure "controlled" crystallisation in any batch type of crystalliser, whereas in a continuously-operated plant the physical conditions are easily maintained. In the case of distillation plants it is far less laborious to design a continuous plant with accuracy to meet a specified set of working conditions. Accurate and robust instruments for measurement, recording, and automatic control of fluid flow, temperature and pressure are now so easily obtained that very little labour or supervision need be required for a continuously-operated plant.

To look forward into the future of chemical engineering is not easy. It will, however, be safe to prophesy that few industries are likely to be free from competitive conditions of production for some years to come, and that the application of the quantitative technique of chemical engineering will extend beyond the strictly chemical trades. It is to be hoped that the future will be able to show inventions ranking in importance with that of Howard. Apart, however, from revolutionary discoveries, the development of still more accurate methods of estimating plant performance quantitatively in advance can be expected. The tendency for manufacturing units to develop on mass-production lines may be expected to lead to increased application of recovery processes and a greater attention to thermal efficiency. Notwithstanding the achievements of the past, the chemical engineer may look forward to the future with the confidence that he can still render valuable service in many branches of industry where inefficiency and faulty design still exist and pass unnoticed.

Calcium Carbide

New British Standard Specification

THE British Standards Institution has issued a new British standard specification for carbide of calcium (642 of 1935, 5s. 3d. post free). This specification has been prepared by a representative committee incorporating a special committee of the British Acetylene Association, under the chairmanship of Mr. C. S. Milne. The genesis of the work arose in 1931 out of a request for approval of a draft specification prepared by the Standards Association in one of the Dominions. Whilst this draft differed from the standards and regulations of the British Acetylene Association, which had been operative for some thirty years, the council of the B.A.A. agreed to co-operate with the B.S.I. in the preparation and establishment of a British standard specification for carbide, based upon their own standards, conditions of sale and purchase and the trade usages in the industry

Special attention has been given to the standards which obtain in other European countries and particularly the methods of test. The specification applies only to carbide of calcium, which is in specified grades and sizes, and is supplied in the original packages as despatched from the factory, which, having regard to the nature of the material can only be applicable when the packages are unbroken and unopened at the time of receipt. The range of standard gradings is specified together with the limits over and under size, and the amount of dust permissible. Limits are laid down for gas yield, scheduled impurities, and the methods for determination of these have been standardised and included in appendices to the specification. The specification also includes detailed descriptions of the methods to be employed for the selection of representative quantities from bulk consignments, and for the preparation of the final samples for testing from the bulk.

An important addition to this specification is given in the form of an appendix containing the conditions of sale and purchase.

Colloid Chemistry in 1935

By WILLIAM CLAYTON, D.Sc., F.I.C.

Dr. William Clayton, Chief Chemist, Crosse and Blackwell Ltd.

OF the very numerous investigations reported during 1935 only a selection is presented with bias on the technical nature or implications of outstanding papers. Many studies have been made on surface films of valuable academic importance, but special attention is drawn to a review on molecular inhomogeneity and surface structure.[1] Lustre films are quite recent and the kinetics of the formation of mono- and poly-molecular layers of copper sulphide on the surface of $CuSO_4$ solution bear on this aspect.[2] The most prominent work, however, is that of Miss Blodgett[3] (with Langmuir) on films built by depositing successive monomolecular layers on a solid surface. Such films are of deep interest for the theory of orientation and wetting. They have been applied for X-ray diffraction research in long-chain compounds.[4]

Hydrophilic Colloids

The isoelectric point of isinglass has been found[5] to be at *p*H 5.9. Colloid chemists now recognise that gelatin does not possess a fixed isoelectric point, a matter of practical importance to food chemists. Three different gelatins have been recently[6] shown to have isoelectric points at *p*H 4.87, 5.09 and 5.65-6.08 respectively. The opinion is given that hydrolysis of collagen is the cause, this giving rise to alteration in the ratio of acid to basic groups in the derived gelatin. Further fractionation of gelatin has been reported,[7] whilst agar-agar has also been fractionated to yield a series of products of different degrees of aggregation.[8]

The estimation of starch may be conducted by acid hydrolysis, enzymatic hydrolysis or precipitation of the iodide. Such methods are not reliable.[9] "The development of highly purified and specific enzymes may solve the problem. Methods based on other chemical and physical properties of starch, such as its solubility in salts and acids and its solubility in iodine and salt solutions deserve closer study." An extensive paper has been published[10] on the nature, distribution and development of pectin and hemicelluloses in cell-wall constituents of plants. The experiments bear on the possible transformation of pectins into hemicelluloses and lignin in the plant and on certain theories of lignification A reversible precipitation of protein occurs when pectin is added to milk. This has been investigated[11] in relation to cheese making, in respect to swelling phenomena and digestibility.

Egg Albumin Studies

The heat denaturation of egg albumin continues to receive attention[12] and a final solution of the problem is still awaited. From a dilatometric study it has been concluded[13] that denaturation is neither a hydration change nor still less an alteration of the content of free acid and basic groups, involving the total electric charge. More likely it corresponds to a primary rupture of the intermolecular attraction between positive and negative atomic groups, leading to curved and strained peptide chains. Larger molecular aggregates form and cause flocculation. Evidence has been presented[14] that the coagulation of isoelectric egg albumin by ultra-violet radiation involves three distinct processes: (1) light denaturation of the albumin molecule; (2) a reaction between this denatured molecule and water; (3) flocculation of the denatured molecules. The light denaturation is unimolecular, independent of temperature and occurs over a wide *p*H range.

Chromatographic adsorption has been exemplified in the preparation of a concentrate of vitamin A at least 40 per cent. more potent than any previously recorded. Adsorption from a pentane solution of the non-saponifiable portion of halibut-liver oil was performed by alumina in an atmosphere of nitrogen.[15]

Food chemists note the development of a new method for determining the foaming power of egg white and testing the foam stability.[16] Egg yolk is an important emulsifying agent due to an unstable complex, a lecitho-protein.[17] Vegetable lecithin has been found[18] to serve as an efficient antioxidant in the protection of edible oils, using 0.05-0.1 per cent. by weight. Probably the active group is free NH_2 or OH, the lecithin inhibiting oil oxidation by forming inactive complexes with any metallic catalysts. The antioxidant power is easily destroyed by heating above 65° C. Unimolecular films of lecithin, lysolecithin, cholesterol and related compounds have been examined by the technique of surface potentials.[19] The peculiar spontaneous change (decomposition) of lecithin even in the absence of air is observed[20] to be associated with an increased negative electric charge and a decrease in the *p*H value of the isoelectric point.

Splitting Proteins by Emulsification

Ten times more effective than lecithin in protecting cholesterol against precipitation by salts or proteins is cephalin, which is also able to protect lecithin against precipitation by proteins.[21] The possibility of splitting proteins by means of emulsification with ether is based[22] on the find-

[1] Funk and Steps, "Kolloid-Z." (1935), **70**, 109.
[2] Mokruschin and Demjanowa, "Kolloid-Z." (1935), **72**, 261
[3] "J. Am. Chem. Soc." (1935), **57**, 1,007.
[4] "J. Am. Chem. Soc." (1935), **57**, 330.
[5] Freundlich and Gordon, "Trans. Faraday Soc." (1935), **31**, 915.
[6] Dulitzkaja and Sokoloff, "Kolloid-Z." (1935), **72**, 205.
[7] Peskoff and Zürupa, "Kolloid-Z." (1935), **71**, 73; Liepatoff and Putilowa, "Kolloid-Z." (1935), **71**, 83.
[8] Liepatoff and Morosow, "Kolloid-Z." (1935), **71**, 317; (1935), **72**, 325.
[9] Sullivan, "Ind. Eng. Chem," Anal. Edn. (1935), **7**, 311. See also, Taylor, Fletcher and Adams, ibid, (1935), **7**, 321.
[10] Buston, "Biochem. J." (1935), **29**, 196.
[11] Ziegelmayer, "Kolloid-Z." (1935), **70**, 211.
[12] Pauli and Weissbrod, "Kolloid-Beihefte" (1935), **42**, 429. Pauli and Kölbl, ibid (1935), **41**, 417.
[13] Haurowitz, "Kolloid-Z." (1935), **71**, 198
[14] Clark, "J. Gen. Physiol." (1935), **19**, 199.
[15] Holmes, Cassidy, Manly and Hartzler, "J. Am. Chem. Soc." (1935), **57**, 1,990.
[16] Bailey, "Ind. Eng. Chem." (1935), **27**, 973.
[17] Sell, Olsen and Kremers, "Ind. Eng. Chem." (1935), **27**, 1,222.
[18] Evans, "Ind. Eng. Chem. (1935), **27**, 329.
[19] Hughes, "Biochem. J." (1935), **29**, 430.
[20] Price, "Biochem. J." (1935), **29**, 1,021.
[21] Spiegel-Adolf, "J. Am. Chem. Soc." (1935), **57**, 1,431.
[22] Djatschkowsky and Liwanskaja, "Kolloid-Z." (1935), **70**, 202.

ings that only certain components of egg albumin serve as emulsifying agents for ether. The active polar part is withdrawn by ether into emulsion, the non-oriented part of the micelle remaining in solution.

Cellulose

Reference is made to a survey[23] of recent work on colloidal aspects of cellulose as related to the technical problems of paper making. Various cellulose preparations adsorb alcohols, pyridine, and especially benzene-alcohol mixtures, the adsorbed liquid not being removed from the fibres even by prolonged heating at 105° C. Removal is effected by washing with ether or water. The adsorption is selective, since ether, benzene and gasoline are not adsorbed. The adsorption causes a marked lowering of the value for the extractive content of sawdust, if that value is determined by weighing the sawdust.[24] The adsorption of NaOH by cellulose is partially irreversible,[25] due to a change in space lattice, and to a swelling which can be reversed more or less completely by heating at about 105° C.

Interesting work[26] deals with the physical properties of cellulose triesters of homologous fatty acids from the acetate to the stearate. The "cellulose" character is progressively submerged as the length of the side chain is increased. Methylcellulose is peculiar in that its aqueous solutions gel on heating and revert to sols on cooling. The addition of salts in small concentrations changes the temperature of transformation, the lyotropic series in regard to the anions being valid. Gel formation is a consequence of a dehydration of the particles.[27]

Dyeing

In the adsorption of dyestuffs by viscose the colloidal condition of the dyes is the main factor in the diffusion of the dye micelles into the intermicellar spaces of the unregenerated cellulose.[28] Substantive dyes in solution at 25° C. vary from the molecular to the highly colloidal state. Addition of NaCl in general increases the size of the dye particles. The tendency of dyes to aggregate is associated with typical groups in the organic molecule. Dyeing at 25° C. on cotton does not progress readily unless the radius of the dye particles is below 17×10^{-8} cm. Solutions which contain dyes of the same particle size do not necessarily exhaust to the same extent.[29]

Condensation Compounds

A bulletin[30] on "The Use of Cellulose, Casein and Other Products in Synthetic Plastics and Resins" describes the main chemical reactions underlying the processes of formation so far as they are known. Phenol aldehyde, cellulose, vinyl and styrene, glyptal, urea and casein plastics are discussed. Polymerised vinyl acetate, polyvinyl alcohol and polysterene have been employed in the restoration of works of art.[31] A waterproof bond for plywood is made from phenolic resin, the most recent development[32] being the application of the resin through the medium of a colloidal suspension of this in water.

Condensation products of polyhydric phenols with formaldehyde possess pronounced and selective adsorptive properties. In consequence they can be used[33] for purification of solutions and the extraction of solutes. Various possibilities arise in water treatment and "by the consecutive use of phenolic and amino-resins it is possible to effect complete removal of dissolved salts from solution, yielding a filtrate equivalent to distilled water."

Exposure of linseed oil and tung oil to ultra-violet light induces some form of polymerisation, as witness the presence of colloidal particles under the ultramicroscope.[34] As expected, linseed oil greatly influences the film properties of phenolic resin varnish.[35] Koroseal[36] is an interesting new plastic. Rubber-like gels result by the treatment of highly polymerised vinyl halides with tricresyl phosphate plasticiser at an elevated temperature, followed by cooling.

A valuable and exhaustive review[37] has been given dealing with the methods of improving the adsorptive power of carbon. Evidence has been presented[38] that a definite relationship exists between the intrinsic adsorptive capacity of carbon as determined by the conventional gas adsorption method and its electrophoretic velocity when suspended in an aqueous medium at pH = 11.5. Activation of carbon is probably a complicated process, but it consists essentially in the removal by oxidation of poisonous hydrocarbons with a freeing of valencies and formation of active centres, together with a general extension of surface area and increase in size of the original pores owing to the removal of carbon by oxidation.[39] Using Norit, adsorption tests have been conducted with a series of structurally related compounds, thereby ascertaining the effect of organic configuration on adsorbability.[40]

Under the title "Behaviour of Oxidising Agents with Activated Carbon," an important use of carbon is described.[41] For example, activated carbon charged with a thin layer of MnO_2 distributed over its extensive internal surface may be employed to purify liquids containing oxidisable impurities or gases containing SO_2, H_2S and mercaptans.

Detergents

Outstanding in this field is the general discussion on colloidal electrolytes held by the Faraday Society[42] which treated theory, soaps, dyes, silicates and silicic acid, proteins, starch and wood fibres. Whilst theoretical considerations received the main attention, practical data on soaps and sulphonated compounds were not neglected. A related communication[43] deals with the wetting and spreading properties of aqueous solutions as evaluated by surface and interfacial tension measurements with reference to a neutral mineral oil.

New work[44] concerns the production of long-chain rhodanates from fatty alcohols, for use as contact insecticides. Data are given for the normal primary compounds in which there is a straight chain of carbon atoms with a terminal rhodanate group, *e.g.*, lauryl rhodanate, $CH_3(CH_2)_{10}CH_2$ SCN. Sulphonated soaps, where the COOH group is eliminated by the sulphonic or sulphuric group, sulphated fatty alcohols and sulphated phenol compounds reflect the modern interest in new wetting agents.[45] Regarding commercial sulphated alcohols, such as the Na salts of the alkyl sulphates of the type of lauryl sulphate,[46] may be quantitatively estimated[47] from the benzidine alkyl sulphate, the organic sulphate by hydrolysis, or less accurately, from the loss at 110° C.

---

[23]Rowland, "Paper Trade J." (1935), **101**, (xiii), 99.
[24]Wiertelak and Garbaczówna, "Ind. Eng. Chem." Anal. Edn. (1935), **7**, 110.
[25]Bancroft and Calkin, "J. Phys. Chem." (1935), **39**, 1.
[26]Sheppard and Newsome, "J. Phys. Chem." (1935), **39**, 143.
[27]Heymann, "Trans. Faraday Soc." (1935), **31**, 846.
[28]Patel, "Silk J." (1935), **12** (No. 135), 19.
[29]Lenher and Smith, "Ind. Eng. Chem." (1935), **27**, 20.
[30]Carpenter and Kucera, N.Y. State Agr. Expt. Sta., "Technical Bulletin" (1935), 230, 1-20. See also Houwink and Klaassens "Kolloid-Z" (1935), **70**, 329; Houwink, "Brit. Plastics Year Book," 1935, 51; Sauter, "Kolloid-Z." (1935), **71**, 356.
[31]Gettens, "Tech. Studies Field Fine Arts" (1935), **4**, 15.
[32]Sontag and Norton, "Ind. Eng. Chem." (1935), **27**, 1,114.
[33]Adams and Holmes, "J. Soc. Chem. Ind." (1935), **54**, 1T.
[34]McCloskey and France, "Ind. Eng. Chem." (1935), **27**, 160.
[35]Turkington, Moore, Butler and Shuey, "Ind. Eng. Chem." (1935), **27**, 1,321.
[36]Brous and Semon, "Ind. Eng. Chem." (1935), **27**, 667.
[37]Herbst, "Kolloid-Beihefte" (1935), **42**, 184-301.
[38]Olin, Lykins and Munro, "Ind. Eng. Chem." (1935), **27**, 690.
[39]King, "Trans. Faraday Soc." (1935), **31**, 935.
[40]Linner and Gortner, "J. Phys. Chem." (1935), **39**, 35.
[41]Behrman and Gustafson, "Ind. Eng. Chem." (1935), **27**, 426.
[42]"Trans. Faraday Soc." (1935), **31**, part I, 422.
[43]Cupples, "Ind. Eng. Chem." (1935), **27**, 1.219.
[44]Bousquet, Salzberg and Dietz, "Ind. Eng. Chem." (1935), **27**, 1.342.
[45]Szegö, "Rev. gen. mat. color" (1935), **39**, 350.
[46]Ginsburg, "J. Econ. Entomol." (1935), **28**, 224; Cory and Langford, ibid, (1935), **28**, 257.
[47]Biffen and Snell, "Ind. Eng. Chem.," Anal. Edn. (1935), **7**, 234. See also Hart, ibid (1935), **7**, 137.

Important investigations have been published[48] on the "Predominant Role of Association in the Dissociation of Simple Straight-Chain Sulphonic Acids in Water." In dilute solution these acids are simple partially dissociated electrolytes, but a remarkable transformation sets in at about N/20 where the electric conductance is at a minimum. This is due to association of *like* ions to form ionic micelle, whose *equivalent* conductance in concentrated solutions attains to that of the hydroxyl ion.

Some new aliphatic amines have been described,[49] useful for their buffered alkalinity, high emulsifying power and their oil solubility. They have considerable uses in the preparation of accelerators, inhibitors, wetting agents, dyes and pharmaceuticals. They are aminoethyl derivatives of ethylene diamine, especially diethylene triamine, triethylene tetramine, propylene diamine, methylmorpholine, etc.

Detergent Solutions

In connection with the properties of detergent solutions investigation[50] has concerned the influence of *p*H on the surface tension of soap solutions. Small changes of *p*H can effect very considerable changes of surface tension, especially with laurates. This work clears up some disturbing differences reported by earlier authors and, in particular, the effects of atmospheric CO_2 on the surface tension of soap solutions are correlated with changes in *p*H due to the CO_2. Of more academic interest is the structural viscosity of homologous aluminium soaps in benzene solution.[51] The function, viscosity/concentration, rises steeply for the middle members (laurate and myristate), less steeply for valerate and palmitate, and is very flat for stearate. Such data can be related to dielectric polarisation and dipole moments, solvation and gel structure.

The Transactions of the Third International Congress of Soil Science (Oxford, 1935) contain matter of fundamental importance to colloid chemists in this field. Bentonites serving as emulsifying agents for Diesel oil insecticidal emulsions differ greatly in their emulsifying power.[52] Their variable swelling[53] property is correlated with the presence of exchangeable Na ions. An extensive review[54] of the literature and patents on the preparation and re-activation of active bleaching earths must be noted. Clay particles are potential bleaching agents for oils when their surfaces hold H and OH ions adsorbed in a thin layer.[55] Driving these off by heating leads to open bonds which selectively adsorb from oil the darker, more basic constituents. Inactive clays (surface bonds held by Fe, Al and Ca) are activated by acids.

Water Attraction

The problem of the nature and magnitude of the force exerted between water and porous materials has importance[56] in many fields, *e.g.*, the weathering of building materials, availability of soil water for plants, plasticity and shrinkage in ceramics, etc. Views have been advanced that the water attraction is due to molecular orientation in thin liquid films on solid surfaces.

Activated sludge exhibits the colloidal property of having exchangeable cations, of like magnitude to bentonite.[57] Further work has been reported[58] on the nature and amount of colloids in sewage and waste liquors. Effective coagulation of the dispersed matter follows the bubbling of gases or even mechanical agitation.[59] The marked superiority of certain hydrophilic colloids over electrolytes for the rapid sedimentation of coarse suspensions has again been studied. Starch and gelatin are particularly effective. New experiment[60] have confirmed the earlier findings of the present writer that flocculation is rapid even when the colloid and the suspension carry the *same* electric charge. It is obvious that fine colloidal solutions in this respect differ profoundly from coarse suspensions, a problem well worthy of full investigation.

Corrosion of iron in oxygenated K_2SO_4 solution at high concentrations of oxygen produces ferric hydroxide and a thin but visible film of ferroso-ferric oxide which adheres to the metal. Organic hydroxy compounds cause retardation[61] of the corrosion, since they are adsorbed on the corrosion products and modify both the character of the loose deposit and the black film beneath. At higher concentrations they peptise such corrosion products and still further reduce corrosion. The number of OH groups and their spatial arrangement in the molecule are important factors, the compounds investigated being glycol, glycerol, erythitol, mannitol and sorbitol.

[48]McBain and Betz, "J. Am. Chem. Soc." (1935), **57,** 1905; 1909; 1913; 1916.
[49]Wilson, "Ind. Eng. Chem." (1935), **27,** 867.
[50]Powney, "Trans. Faraday Soc." (1935), **31,** 150. See also, Lottermoser and Giese, "Kolloid-Z." (1935), **73,** 155.
[51]Ostwald and Riedel, "Kolloid-Z." (1935), **70,** 67.
[52]Carter, "J. Econ. Entomol." (1935), **28,** 268.
[53]Hofmann, Endell and Bilka, "Z. Elektrochem." (1935), **41,** 469.
[54]Krczil, "Kolloid-Z." (1935), **71,** 121.
[55]Nutting, "Bull. Am. Assoc. Petroleum Geol." (1935), **19,** 1,043
[56]Wilson, Bonnell and Nottage, "Trans. Faraday Soc." (1935), **31,** 1,304.
[57]Setter, Ridenour and Henderson, "Ind. Eng. Chem." (1935), **27,** 1,228.
[58]Mills, "J. Soc. Chem. Ind." (1935), **54,** 305T.
[59]Williams, "J. Soc. Chem. Ind." (1935), **54,** 355T.
[60]Wilkins, "J. Soc. Chem. Ind." (1935), **54,** 391T.
[61]Patterson and Culbert, "J. Soc. Chem. Ind." (1935), **54,** 327T.

Institute of the Plastics Industry

Developments in 1935

THE Institute of the Plastics Industry has continued its development throughout the past year, holding meetings each month during the winter in London, Birmingham and Manchester.

The opening meeting of the year for the South London and district section was a three-cornered discussion on "The Value to the Plastics Industry of (a) the Chemist, (b) the Engineer, and (c) the Salesman." Mr. George Dring opened for the chemist, followed by Mr. C. R. Baggett on behalf of the engineer, and Mr. P. G. Ridd as a salesman. Another interesting evening was "Cast Phenolic Resins," by Dr. G. Leysieffer, of Dynamit A.G., the lecturer's remarks being illustrated by a wonderful display of exhibits. In March a joint meeting was held with the Plastics Group of the Society of Chemical Industry, when the sound film "Bakelite, the Material of Infinite Uses" was shown and Mr. H. V. Potter gave an address. The April meeting was devoted to a lecture on "Patents and Designs, with some reference to the Plastics Industry" by Mr. N. H. Buckley.

During the year the Midlands section held six meetings. The October meeting was specially interesting as it took the form of a debate on "What is Wanted from the Plastics Industry?" Another interesting evening was the lecture by Mr. C. Wainwright on "An Outline of Test Procedure Applicable to Synthetic Resin Moulding Materials and Laminated Boards." Another debate took place on "Wage Systems in the Plastics Industry," when Mr. Kenneth M. Chance and Mr. H. W. Rowell were the leading speakers. The new season was opened on October 18 with a display of cinematograph films, (a) the Bakelite film, and (b) the Beetle film.

The recently formed Northern section organised a good programme. An interesting evening was that on which a lecture on "Characteristics of Plastics Required for the Electrical Industry" was given by Mr. A. R. Dunton. In January the local hon. secretary, Mr. H. Jones, read a paper, "Some Aspects of Plastics, and, in particular, Colour." A joint discussion was held with the Institution of Production Engineers in October, when the Bakelite sound film was shown.

In addition to these lectures, a number of social events and visits to works were organised. A successful function was the fourth annual dinner and dance, held at the Hotel Russell, on February 14. This function was supported by the president, Lord Melchett, and Mr. Edwin Thompson, J.P., was the guest of honour.

Progress in the Colouring and Finishing of Textile Materials

By A. J. HALL, B.Sc., F.I.C., F.T.I.

Mr. A. J. Hall

IN reviewing the amount of new knowledge concerning textile processing which has become available during the past year one cannot but be astonished at its diverse yet comprehensive character and the scattered sources from which it is derived. Formerly, England and Germany were mainly responsible for new developments in the bleaching, dyeing and finishing of textile materials, but more recently America, Italy, Japan, Russia, and even China, have commenced to make really valuable contributions to textile progress. America particularly is taking a much greater interest in research on textiles, and it is believed that the examples of our Research Associations for cotton, wool, linen, and silk have done something to arouse this increased interest.

Just as finishing must in general be preceded by dyeing or printing, so must these processes in their turn be preceded by preparatory treatments such as scouring, bleaching, mercerising, and carbonising. It will therefore be useful to deal first with recent developments in the preparatory treatments through which most woven and knitted textile materials pass.

Soap Substitutes

During the past year no striking advance has been made in soap substitutes. Sulphonated fatty alcohols such as Igepon, Gardinol, Lissapol, etc., have now found their useful place in textile scouring and no new compounds have been discovered to challenge them. But in Calgon (sodium hexametaphosphate) is to be found an assistant which, whilst having only small detergent properties of itself, can be used to maintain the solubility of soap in hard water with considerable efficiency. It is likely that this inorganic product will ultimately attain much importance as a textile auxiliary product in all processes in which soap is employed. When Calgon is added to hard water the calcium and magnesium salts which are causing the hardness are rapidly transformed into complex phosphates which are non-reactive towards soap so that all possibility of lime soap formation is prevented:

$$(NaPO_3)_6 + 2CaSO_4 = 2Na_2SO_4 + Na_2[Ca_2(PO_3)_6].$$

One of the most interesting preparatory processes recently devised for wool and claimed by E. H. Barker ("Text. World," 1935, *85*, 1085) to have yielded excellent results on a large scale is that in which advantage is taken of the friable character assumed by the impurities (pitch, tar, natural fats, etc.) when wool is frozen at about − 20° C. In this process, raw wool is led through a freezing chamber and immediately afterwards passes through a breaking machine where the impurities are disintegrated and removed by a blast of air. The purified wool retains its normal physical properties but its colour is better than when the impurities are removed in the usual manner by simple scouring with soap.

Wool Scouring Difficulties

In scouring wool care must be taken to avoid felting. It is of interest to note that a type of soap containing up to 50 per cent. of a fatty alcohol having 8 to 15 carbon atoms has been discovered (Brit. Pat. 424,283) which does not facilitate felting, and it should therefore be of considerable use in cleansing wool goods. H. A. Neville and M. Harris ("Bureau of Standards J. Research," 1935, *14*, 765) have shown that in soap solutions wool absorbs the alkali of the soap preferentially whilst cotton does not. Stoving wool goods with burning sulphur still remains a widely used method for bleaching wool materials, it being generally agreed that bleaching with hydrogen peroxide is more expensive although more permanent. Details of the construction of sulphur stoves for this purpose have been given by E. P. Santcrosse ("Amer. Dyestuff Rep.," 1935, *24*, 418), it being useful to note that wood, concrete and brick are satisfactory in general, but the last two materials induce precipitation of sublimed sulphur if allowed to become too cold. Lead sheet is satisfactory as a roofing material and aluminium hooks for hanging the wool goods are suitably resistant to corrosion.

Any alkali treatment of wool must be carefully controlled in order to avoid that damage to the wool which is so easily produced. Recently M. Harris ("Bur. of Standards J. Research," 1935, *14*, 63) has carefully investigated the reactivity of wool and finds that caustic soda causes an initial rapid decrease in the sulphur content of the wool, but that simultaneously the wool sulphur is changed into a more stable form so that further splitting-off of sulphur is retarded and the sulphur content of the wool approaches a low limit of 1.8 per cent. Previous oxidising or reducing treatments render the wool more susceptible to damage by alkalis.

The Degumming of Real Silk

Real silk is prepared for dyeing by a preliminary degumming treatment and this process has been investigated closely by A. O. Hougen and others ("Text. Research," 1935, *5*, 92, 134, and 191). It has been shown that the chemical factors involved in the usual degumming with a boiling soap solution are different from those when alkaline substances such as sodium silicate, sodium carbonate, borax and caustic soda are used as degumming agents. Within safe limits, the concentration of such alkalis has but little influence on the rate of degumming, whereas with soap there is an optimum concentration of 0.053 N. In degumming with soap, the sericin chemically combines with the alkali of the soap so that the degumming liquor acquires a free fatty acid content. Possibly this emulsified acid acts as a protective colloid towards the silk fibre, thus preserving its desirable characteristics, whereas with such alkaline degumming agents as caustic soda and sodium carbonate the fibre becomes harsher in handle and yellower in colour.

During several years, sodium silicate has been used as a stabiliser in hydrogen peroxide baths used for bleaching silk. It has more recently been found that salts of the pyrophosphoric esters of aliphatic alcohols containing more than seven carbon atoms are excellent for this purpose (Brit. Pat. 421,843) and they have the further advantage of being penetrating agents. M. Bernard ("J. Soc. Dyers and Col., 1935,

51, 390) has disclosed that phenetidine lactate is also a good stabiliser for hydrogen peroxide solutions. No important developments have occurred in bleaching methods for cotton and linen, but a stable yet very concentrated form of bleaching powder (70 per cent. available chlorine and only 7.5 per cent. of calcium chloride) known as Perchloron is now available (L. L. Hedgepeth, "J. Soc. Dyers and Col., 1935, *51,* 220).

For many years it has been known that yarn spun from mercerised cotton usefully differs in many of its properties from mercerised cotton yarn, and recently interest has been revived in the usefulness of the former type of yarn. A method for mercerising cotton rovings or slivers under tension has been perfected (Brit. Pat. 418,150), so that loose mercerised cotton fibres suitable for spinning can be produced. The effect of various conditions of mercerising on cotton fibres has been investigated by K. Langer (" Textilber.," 1935, *16,* 507), and it is found that fibres kiered previous to mercerising have a 70 per cent. higher tensile strength than similar fibres not previously kiered.

Increasing Fastness to Water

Various substances have now been discovered for increasing the fastness to water of cotton dyed with direct dyes. Among these may be mentioned quaternary ammonium compounds (Brit. Pat. 423,933, 427,089 and 434,911). With these substances it is merely necessary to treat the dyed cotton with their warm aqueous solution, then rinse and dry. But the problem of making direct dyeings faster to washing has also been tackled in another manner, that is, by forming a synthetic resin compound within the dyed material and so making the dye water-insoluble; formaldehyde resins appear to be favoured for this treatment (Brit. Pat. 429,209). A similar principle underlies the addition of urea or its derivatives to printing pastes using metalliferous dyes (Brit. Pat. 418,262). According to Brit. Pat. 427,058, the presence of urea, together with a phenol and furfuryl alcohol, so assists the fixation of water-soluble dyes that the resulting prints are much faster to washing. Impregnation of dyed fabric with rubber latex is claimed by G. D. Kratze and W. M. Spencer (" Rayon and Melliand Text. Monthly," 1935, *16,* 76) to make direct dyes present faster to washing.

In dyeing wool materials it is nearly always essential to employ a boiling dyebath in order to secure good penetration, although it is known that such high temperature treatment is not beneficial to the wool itself. Hence the value of a discovery by the staff of I.C.I. (L. P. Rendell and H. A. Thomas, " J. Soc. Dyers and Col., 1935, *51,* 157) that it is possible to dye with excellent penetration and levelness thick wool materials in a dye liquor at 80 C. through which is bubbled air. It is considered that the air turbulence causes a bombardment of the wool by the dye particles and also a " breathing " of the wool, such that it more readily absorbs these particles. It is understood that dyeing machine makers are co-operating with I.C.I. to make machines suitable for applying this new dyeing technique.

Professor F. M. Rowe has continued his researches on the insoluble azoic colours (" J. Soc. Dyers and Col." 1935, *51,* 278 and 314). The action of boiling caustic soda on a number of azoic dyes has been determined and it has been established that the presence of a nitro group in the dyestuff molecule impairs its fastness to alkali-(kier) boiling. The relative fastness to kier boiling of azoic dyes containing no nitro group can be ascertained by boiling with 0.36 per cent. caustic soda in the laboratory.

Anti-Crease Finishing

During the past year the anti-crease finishing process of Tootal Broadhurst Lee and Co., Ltd., has been extended satisfactorily to linen, which, incidentally, has been shown to be the most brittle of the natural fibres. No serious competitor to this formaldehyde-urea finish has appeared, but many interesting facts relating to it have been published by C. Amick ("Amer. Dyestuff Rep.," 1935, *24,* 553, 622 and 645).

Numerous new tests have been devised for dealing with dyed and finished materials. Interesting among these is a method of Trotman and Bell (" J. Soc. Chem. Ind.," 1935, *54,* 135T) for estimating the damage in real silk by measuring its viscosity in zinc chloride solution. The Goetze method of determining the damage in linen has been confirmed by K. Schwertassek (" Textilber.," 1934, *15,* 513) and L. P. Michel (" Rev. Gen. Tein. Imp. Blanch. App.," 1934, *12,* 495, 679 and 745) has surveyed very thoroughly methods for measuring the degree of mercerisation of cotton. V. G. Abozin ("Trans. Leningrad Chem. Tech. Inst.," 1934, *1,* 215) has also described a novel means for testing mercerised cotton.

Society of Public Analysts

Membership Now 750

THE membership of the Society of Public Analysts continues to increase steadily as it becomes more widely recognised that the Society is not only concerned with the interests of Public Analysts, but is also the only society in this country devoted to the development of analytical chemistry in all its branches, and is therefore open to all analytical chemists. The membership roll now stands at 750.

During the year 25 papers were read and discussed by the Society, and several papers were also read before the North of England Section and the newly-formed Scottish Section. In addition a large number of papers and notes were published without being previously read. The summer meeting of the North of England Section was held at Harrogate in June, and was well attended, including members of the parent society and the Scottish Section. Several investigations have been carried out under the Society's Analytical Investigation Scheme, and the results have been published in " The Analyst." The scheme is not restricted to members of the Society.

Leather Trades Chemists

Formation of New Sections

DURING 1935 the International Society of Leather Trades' Chemists held its bi-annual conference at the Institut-des Arts et Metiers, Brussels, at which some 30 papers dealing with the chemistry of leather manufacture and related problems were read and discussed. The conference lasted four days, and attracted some 200 leather trades chemists from all parts of the world. The president elected for the period 1936-37 was Mgr. G. Colchen, the president of the Belgian Section of the Society, the vice-presidents being M. C. L. Loos (France) and Mr. W. R. Atkin, M.Sc. (Leeds). Dr. J. Gordon Parker, who for a number of years has been hon. general secretary of the Society, was elected an honorary member.

The growth of this international scientific body is indicated by the steady formation of new sections. Last year, the formation of a Portuguese section was announced, while during 1936 it is hoped to found a South African Section through the good offices of Professor W. F. Barker, of Rhodes University College, Cape Province. In England the British Section of the Society may be better known than the parent body as a whole. This section has experienced considerable popularity through the organising of symposia on specific subjects but allied in some way to the broad science of leather chemistry. In 1934, that on " Technical Aspects of Emulsions " was particularly successful, while during 1936 it is hoped to hold one on some aspects of the working of dyeing.

This section is also working in close co-operation with the British Standards Institution and certain Government Departments. Combined meetings with the Federation of Curriers and Light Leather Tanners have proved equally successful and are appreciated by the entire industry.

The president of the British Section for 1936 is Mr. M. C. Lamb, with Dr. R. H. Marriott as vice-president. The membership of the whole Society has again increased in spite of the international difficulties.

Fatty Oils and Soaps in 1935

By Professor T. P. HILDITCH, D.Sc., F.I.C.

Professor T. P. Hilditch, Professor of Industrial Chemistry, Liverpool University.

NOTHING very exciting seems to have happened in the fatty oils and soaps field during 1935; that is to say, nothing with "news value"—such as the discovery of a new vitamin of outstanding power, of a new product which will supersede all present-day soaps or make best dairy butter a commodity to be pitied rather than sought. This is not regretted so far as the writer is concerned. It is more congenial, if also more difficult, to attempt to indicate a few of the intricate problems on which attention is concentrated at the present time: to suggest, it may be, that the resultant of the intensive study now being given in factory and in laboratory to all kinds of aspects of fats and detergents, their properties and uses, is leading to marked progress of permanent value—perhaps more permanent than that which sometimes results from isolated and striking discoveries.

Colloidal Electrolytes

The Faraday Society has published in monograph form the papers and discussions on colloidal electrolytes resulting from their conference in London in September, 1934. The volume contains mathematical and physico-chemical disquisitions of a purely academic and abstruse nature and also contributions equally academic but more directly in touch with technical problems, together with a number of papers presented by technical experts which deal with definite practical applications of colloidal electrolytes. This discussion is an apt illustration of the remarks above. It is not unfair to say that few, if any, of the individual contributions dwell upon any sensational advance or information; yet the synthesis achieved by frank discussion between chemist and technologist, the appreciation of different aspects which workers of one outlook receive from or convey to those of another, is the obvious path to real and more rapid progress. Approach on these lines to a problem so complex and in some ways so elusive as detergent activity is definitely sound and worthy of all support.

In the field of detergents the functions of the newer classes of products—for example, the sodium salts of higher fatty alcohol sulphates—as compared with soaps can be assessed adequately only by detached scientific comparison. One rather received the impression, when certain of these products were first put on the market, that soaps in the ordinary sense of the word might soon come to be regarded with the same compassionate feelings as when one compares the "Victory" with the "Hood," or Stephenson's "Rocket" with a modern express locomotive. Judging from more recent published reports, there is now uncertainty in some quarters as to how far the new detergents are useful. Whilst it is difficult to be quite certain how far scientific impartiality may be always perfectly sustained in discussions of this kind, it is in any case not easy to determine at the outset the behaviour of a detergent assistant in respect to all types of fabric and to all the varied conditions of use.

There can be no doubt that many of the sulphate and sulphonate types of detergents have useful properties which ordinary soaps lack. They form reasonably soluble calcium and magnesium salts, some are even effective and comparatively stable in mildly acid solutions, and some have pronounced wetting-out, dispersing or other properties. On the other hand, the discussions—chiefly in the Continental and American Press—of the past year suggest that in actual washing power ordinary soaps may be superior to the new products. It is still difficult to define detergency in terms of a measurable property or combination of properties; but soaps of the oleate type possess something (usually termed "body") which enables them to cleanse heavily-soiled material, at all events, exceptionally well. At present it seems generally agreed that lightly soiled fine textile fabrics can be equally well cleansed by the newer agents and that with coloured fabrics the effect is brighter than when soap is employed. For coarser fabrics or removal of heavy soiling, and for general household purposes, the newer products will find most use (if one rightly interprets the trend of current published opinions) as assistants to or in conjunction with soap. Yet even here opinions differ, and one is inclined to agree with Holden and with Welwart in their suggestions that much may depend upon the selection of the optimum proportion of fatty sulphate salt to soap. The sulphated products are quite probably capable of altering the physical structure of the colloidal soap solution as well as, for example, of dispersing or "solubilising" insoluble calcium soaps or other suspensions. One is left with the feeling that there is room for much further technical investigation in order to make fullest practical use of the valuable properties of the sulphated detergents in conjunction with, rather than in opposition to, the employment of the old-fashioned soaps.

Sulphated Detergents

The sulphated detergents, and also triethanolamine soaps, are proving increasingly valuable as constituents of shaving creams (applied without water or brush) and of "oil" or "soapless" shampoos for the hair, and in toilet soaps and dentifrices. Here again it appears that judicious proportioning is essential to attain the best results, since, for instance, the same constitutive features which are responsible for wetting and penetrating power will promote removal of the natural hair or skin fats, leading to excessive dryness or irritation. Scientific control will continue to lead to the elaboration of formulæ giving maximum efficiency without any undesired effects.

In the production and refining of fatty oils the chief feature of the year appears to be the further examination of recently suggested processes rather than the development of many new ones. Work of this nature has been recorded concerning two methods of treatment of oilseeds prior to extraction of the fat. The Beckmann fermentation process, in which the fat is first partially liberated from the cells by the action of specific bacteria, is considered by Horovitz-Vlassova and Novotelnov to be due to the combined action of lactic acid and of proteolytic enzymes which diffuse into the oil-cells and render the proteins soluble. Their experiments show that, although

the method is successful with copra, walnuts and cedar-nuts, it fails with hemp, maize, castor and some other seeds; in these cases, perhaps, either the cell walls are less permeable to lactic acid or the fat-protein emulsion is more stable. In the Skipin process, which consists in preliminary cooking of the seed-meal with water, Goldowski and Gluchow find that there is an optimum water content and also an optimum temperature of heating, both of these varying with different kinds of seed. Oil-rich seeds demand a lower temperature, for example, than those of low fat content.

In Germany, as in Russia, increasing attention is being given to research on hybridisation of oil-bearing plants with the aim of securing species with oil-rich seeds which can be successfully cultivated in the countries concerned.

Deodorisation of Fats

The modern distillation methods for continuous deacidification and deodorisation of fats, to which passing reference was made in a corresponding article last year, continue to receive a good deal of attention in the literature and are evidently making headway. Such plants can also be employed with advantage in the distillation of fatty acids (oleines, etc.). It appears that in Italy the free fatty acids from the lower grades of olive oil are being thus purified and then reconverted into triglycerides so as to produce " synthetic " olive oils. Products of this kind should be quite edible in the sense of digestibility, but will not be, for several reasons, identical with a natural olive oil of the first grade.

Great activity is to be observed in the attempted standardisation of the numerous methods of technical analysis employed not only in process control, but also in the marketing of fatty oils and soaps. An International Commission for this purpose has met annually in various European capitals during the past few years, and its proceedings have been reported in several of the industrial journals. There is bound to be a certain amount of difficulty in arriving at any rigid standardisation and to attempt to enforce any such standard methods would, it seems to the writer, be quite abortive. In Germany a number of such procedures have been laid down more or less authoritatively for some years past. Again, the larger industrial organisations have made their own choice of the most appropriate analytical methods in each case and are not likely, without very good reason shown, to be moved to depart from the decisions reached by their own chemical staffs. On the other hand, the existence of analytical processes agreed as a result of conference between representatives of different countries should prove of considerable value in providing approved methods as standards of reference in cases of dispute, even if the acceptance of such methods as absolute standards is perhaps hardly to be expected.

Rancidity of Edible Fats

Committees of the American Oil Chemists' Society are also much occupied with similar work, both in the more generally used methods for fat analysis and also in the analysis of commercial glycerine. They are most active, however, in efforts to agree upon settled procedures for the assessment of rancidity in edible fats, and especially for detecting the liability of edible fats to develop oxidative rancidity. In this direction a great deal of valuable work is being done in defining the best mode of using, and the general applicability of the " peroxide value " test.

At home the Society of Public Analysts carries out a similar function in its sub-committee on the determination of unsaponifiable matter in fats, soaps, etc., which has issued a report on the determination of unsaponifed fats and unsaponifiable matter in soaps. The terms of reference of the original sub-committee have now been fulfilled, but it has been reconstituted as a permanent sub-committee to study and report upon methods of soap analysis.

There is not much room left in which to review the new knowledge which is coming forward with regard to the ultimate composition of the natural fats. Research in this field is fully maintaining the activity which has characterised it of recent years. Studies of the component acids and glycerides of fats not previously investigated have been reported from many quarters. Additional studies of some of the more common fats have been made by examining the fully-saturated glycerides which are produced at progressive stages of hydrogenation of the original material.

It is very satisfactory that the modern methods of detailed analysis, which have proved so fruitful with depot or reserve fats, are being steadily extended to the liver fats of various animals, terrestial and amphibian. Klenk has continued his valuable investigations on this subject, and in several instances has collected data for the depot glycerides, the liver glycerides and the liver phosphatides of the same animal. As the number of species studied slowly increases, it is possible to detect signs of characteristic differences in these three classes of fatty compounds which were hitherto obscure. It has been stated on previous occasions that in the depot fats of animals, from the terrestial, through the amphibian, to the wholly aquatic type, there is a progressive change in the character and composition of the mixed fatty acids. It now begins to appear that similar relationships may hold for the liver glycerides and phosphatides; these tend in general more towards unsaturation and, indeed, the increased unsaturation as compared with corresponding depot fats is due mainly to the presence of highly unsaturated acids containing 20 and 22 carbon atoms in the molecule. Moreover, the liver phosphatide fatty acids, in any given animal, seem to contain a much higher proportion of the latter acids than the liver glyceride acids. These, and other, relationships between the components of the various fatty acid mixtures will undoubtedly, when sufficient examples have been collected, provide a group of quantitative data which will illuminate, from a new angle, the processes by which fatty acids are metabolised in the animal organism; and it is reasonable to think that not a little revision of the views at present held with regard to these processes will be entailed in the not too distant future.

Poly-Unsaturated Acids

Finally, one would like to refer to recent discoveries concerning the constitution of poly-unsaturated acids which occur in natural fats. The conjugated triethenoid elaeostearic acid, as is well known, is the major constituent of the glycerides of tung oil. Oiticica oil, possessing somewhat similar properties to tung oil, was believed to contain an isomeric form of this acid, termed couepic acid: but E. H. Farmer and W. B. Brown have shown that an important constituent is a ketotriene acid (licanic acid) of the formula $CH_3.[CH_2]_3.[CH:CH]_3.[CH_2]_4.CO.[CH_2]_2.COOH$. This is an entirely novel type of acid to occur in a natural fat, its nearest (but not very close) analogue being ricinoleic acid of castor oil, in which a hydroxyl group and one double bond are present. The existence of licanic acid of this formula has been confirmed by Kappelmeier, who believes that elaeostearic acid may also occur with it in oiticica oil. Farmer and his co-workers have also isolated a conjugated tetraethenoid acid, $CH_3.CH_2.[CH:CH]_4.[CH_2]_7.COOH$, from the seed-fat of *Parinarium laurinum*, while those of *P. macrophyllum* and of *Telfairia occidentalis* contain elaeostearic acid. The latter observations lead to the unusual feature that the comparatively rare elaeostearic acid has now been recognised in the seed-fats of single species belonging to three different plant families—Rosaceae, Euphorbiaceae and Cucurbitaceae.

Similar work is actively proceeding, especially in the hands of Japanese chemists, upon the much more complex mixture of unsaturated acids present in abundance in the fish oils. Definite structures have now been found for most of the monoethenoid acids (C_{16} to C_{24}) in these oils, but the composition of the tetra- and penta-ethenoid C_{18}, C_{20} and C_{22} acids, although much studied, cannot be said to be finally settled: during the past year, however, structures have been assigned by various workers, notably Toyama and Tsuchiya, to acids of the formulae $C_{16}H_{26}O_2$, $C_{18}H_{28}O_2$, $C_{20}H_{32}O_2$ and $C_{20}H_{30}O_2$.

The Nitrogen Industry in 1935

By E. B. MAXTED, D.Sc., Ph.D., F.I.C.

Dr. E. B. Maxted.

IN spite of a still existent large excess of producing capacity over present requirements, it is possible to trace once more a definite upward trend in the world consumption of nitrogen; and it is pleasant to see again, after the years of depression, the rising portions of the statistical curves in publications such as the last report of the Sulphate of Ammonia Federation Detailed figures for the past year are not yet available; but the last-published report of this Federation[1] shows that the total world consumption of nitrogen increased by 6.6 per cent. over that of the previous year, which in turn had shown an increased consumption of over 12 per cent. Home consumption was, however, slightly less, but the more satisfactory position was reflected in higher prices. To keep pace with this increased demand, total production increased approximately in proportion. Special interest is attached to the relatively great increase, amounting to over 20 per cent., in the production of Chile nitrate, particularly since this follows a previous decrease. Nevertheless, the full working capacity of existing plants is by no means fully utilised.

In Germany,[2] fixed nitrogen plants are working at about 40 per cent of their capacity, and exports have been reduced by the construction of new plants in importing countries, particularly in the Far East. The capacity of plants, for instance, in Italy also tends to increase.[3] It may be noted that the world capacity for fixed nitrogen is estimated by various statisticians at figures lying between 30 and 40 million tons a year.

Synthetic Ammonia

In view of the low price of ammonia, attention continues to be directed towards a cheapening of the manufacture of the hydrogen which is a key constituent in determining the cost of synthetic ammonium salts. Thus, A. Thau[4] has described the manufacture, at a Hungarian works, of gas suitable for the synthesis, starting with low-grade fuels. Producer gas is made in special producers and is converted to a nitrogen-hydrogen mixture in the usual way. Further, the production from lignite of gas for use as a raw material for ammonia has been dealt with by W. Allner.[5] The tar vapours resulting from the carbonisation of lignite are cracked, in the presence of steam, by passage over incandescent coke. Figures are given for an actual plant producing 5,000-7,000 cubic metres of gas a day. The tendency in the industry is to use cruder and cruder gas, this gas being subsequently either caused to react with steam, with production of hydrogen at the expense of its carbon monoxide content, or subjected to a low-temperature separation process. Nevertheless, the ultimately required degree of freedom from poisons is extremely high.

Economics of Manufacture

Of great interest are the notes on the economics of the synthetic manufacture of ammonia,[6] together with the corresponding notes on the production of hydrogen,[7] contained in a series of articles published in THE CHEMICAL AGE. Although these notes were originally compiled in 1918, a great part of the economics is still valid; and the completeness of the treatment makes the series of considerable importance from a chemical engineering standpoint.

The well-known standard methods of purification, which usually involve the conversion of any trace of carbon monoxide into methane and the subsequent treatment of the gas with a preliminary charge of the catalyst used in the main synthesis, in a so-called pre-catalyst chamber, are so satisfactory that radical improvements are not very probable. However, two patents dealing with purification may be noted. In order to remove carbon dioxide, A. E. Hecker[8] proposes mixing the gas to be purified with gas containing ammonia in order to form ammonium carbamate, which is then separated. Another purification method of somewhat similar nature consists in preheating the crude gas by exchange with the main gas circuit, then treating the heated gases in a pre-catalyst chamber. This is followed by the admixture of synthesis gas, the impurities being then condensed out.[9]

Standardised Catalysts

Similar remarks apply with regard to standardised catalysts and general plant and procedure. Catalysts containing titanium, in addition to iron and the more usual promoters, have been investigated by Russian workers. Thus, according to J. P. Geid,[10] a catalyst of very satisfactory activity may be made by fusing titanomagnetite with potassium aluminate. Modifications in plant have received little attention, so far as the published literature is concerned. Reference may, however, be made to proposals for a special arrangement which have been put forward by D. Pyzel.[11]

A striking tribute to the cheapness of synthetic ammonia is the suggestion by C. Tyler[12] to use cracked ammonia as a cheap source of hydrogen, particularly in small installations, for the hydrogenation of oils. The manufacture of poison-free hydrogen on a small scale, for instance, by electrolysis, is a serious handicap to small oil-hardening installations, and ammonia certainly provides what is tantamount to a convenient means of transport of hydrogen produced in large and economic plants; but the dilution by nitrogen of the hydrogen produced by cracking would seem to preclude its use, particularly in closed-circuit plants of normal type. It might, however, be of interest in a series arrangement of vessels, in which the accumulation of an inert impurity is less obstructive. The use of liquid ammonia as a dehydrating agent has been described by A. M. Monoszon, E. N.

[1] THE CHEMICAL AGE, 1935, **32**, 25.
[2] THE CHEMICAL AGE, 1935, **33**, 416.
[3] THE CHEMICAL AGE, 1935, **33**, 254.
[4] "Brennstoff-Chemie," 1935, **16**, 61.
[5] "Gas-und Wasserfach," 1935, **78**, 438.
[6] THE CHEMICAL AGE, 1935, **33**, 301, 325, 350, 378, 398, 423, 446.
[7] THE CHEMICAL AGE, 1935, **33**, 470.
[8] U.S. Pat. 1,940,860.
[9] P. Christin, U.S. Pat. 1,951,819.
[10] "J. Chem. Ind. Russ.," 1934, **10**, No. 9, 46; ex "Brit. Chem. Abs.," B, 1935, 20.
[11] U.S. Pat. 1,957,849.
[12] "Oil and Soap," 1934, **11**, 231.

Gurjanova and A. I. Schatenschtein[13] in connection with the dehydration of magnesium chloride; and there would seem to be a possibility of the extension of this method for other dehydration processes. Finally, the preparation of anhydrous liquid ammonia in gas works and coke oven plants has been discussed by R. Zaniboni.[14] Removal of water is effected in a dephlegmator assisted by treatment with lime.

Ammonium Salts

The effect of impurities and of change of temperature during crystallisation on the production of large crystals of ammonium sulphate has been re-examined by G. Berkoff.[15] The precipitation of iron and other metallic salts in the form of phosphates is recommended, and rapid cooling of the solution during crystallisation should be avoided. The addition of phosphoric acid in order to precipitate impurities and to assist in crystal formation is also dealt with in a patent of the Staatsmijnen in Limburg.[16] This method may be compared with that which has been proposed by the Union Chimique Belge and J. Guilissen,[17] according to which the removal of impurities from the mother liquors of ammonium sulphate plants is effected by a process involving the addition of ferrous sulphate.

The manufacture of ammonium chloride from calcium chloride and ammonium sulphate has been dealt with by T. A. Borradaile.[18] The process consists in removing the precipitated calcium sulphate and in adding barium chloride to complete the removal of sulphate. The preparation of ammonium sulphate-nitrate without the use of previously-made sulphuric acid has been studied by S. Volfkowitsch, A. Dubovitzki and N. Kriutschkov.[19] Air, together with oxides of nitrogen, was passed into a solution of ammonium sulphite at 45° C. and the velocity of the reaction under these conditions was investigated. This method is equivalent to a combination of the chamber process for the manufacture of sulphuric acid with the manufacture of a mixed ammonium salt. The production of ammonium salts from acidic by-products has also received renewed attention. Thus, the Bataafsche Petroleum Maatschappij and F. M. Pyzel[20] have dealt with the preparation of ammonium sulphate from the acid sludge which is available from the refining of petroleum. The sludge is aerated to reduce its sulphur dioxide content before treatment with ammonia.

The ammoniation of superphosphates has been treated in several papers and patents. Among these may be mentioned the especially comprehensive study by L. M. White, J. O. Hardesty and W. H. Ross[21], in which the reaction of ammonia with the so-called double superphosphate is discussed. In view of the heat developed during the process, effective cooling, accompanied by stirring, is necessary to give a granular product and to prevent the decomposition of any urea or diammonium phosphate present.

Nitric Acid and Nitrates

The causes underlying the rise with time in the activity of platinum gauze in the oxidation of ammonia have been discussed by I. E. Adadurov and P. D. Didenko.[22] The rise in activity which is observed after prolonged heating in hydrogen is ascribed to volatilisation assisted by the hydrogen present. S. L. Handforth and J. N. Tilley have studied in considerable detail the activity of a large number of binary and ternary alloys containing platinum or one of the platinum metals,[23] particularly from the standpoint of platinum loss and of the general efficiency. Of these, an alloy containing 90 per cent. of platinum and 10 per cent. of rhodium was the most effective. The use of platinised copper or brass gauze for the oxidation of ammonia has been investigated by I. E. Adadurov and P. D. Didenko.[24] The combination was found to wear out quickly and, an any case, a maximum yield of only 74 per cent. was obtained. Work on non-platinum catalysts has been carried out by L. Marmier,[25] in the course of which special emphasis is laid on the activity of chromium, with which conversions almost equal to those given by platinum were obtained.

G. A. Kramer and L. Rosenstein[26] have dealt with a process for the oxidation of ammonia in conjunction with an enrichment method for the concentration of the nitric acid produced. For details of the fractionation and enrichment procedure, which are the special feature of the process, reference should be made to the original patent specification. Concentration of nitric acid by enrichment has also been the subject of proposals by the Lonzo Elektrizitätswerke.[27] The patent in question relates to the regulation of the temperature gradient in the column in which the dilute nitric acid or water is treated with oxides of nitrogen under pressure. Finally, in connection with analytical procedure, reference may be made to the remarks of W. A. Damon[28] with regard to the estimation of oxides of nitrogen.

Several modifications have been proposed in the manufacture of alkali nitrates. Thus, in a process for the preparation of potassium nitrate, which has been suggested by L. Holz,[29] calcium carbonate is dissolved in nitric acid and the solution treated with potassium sulphate, whereby the greater part of the calcium is precipitated as sulphate. The remainder of the calcium is removed as the carbonate, by admixture of ammonium carbonate. The solution then contains potassium nitrate and ammonium sulphate, which are crystallised out in the usual way. A further method, due to A. Guyer and A Bieler,[30] consists in the interaction of calcium nitrate with potassium chloride in liquid ammonia solution when calcium chloride is precipitated and may be removed by filtration. The manufacture of alkali or ammonium nitrates by the interaction of nitric acid with the corresponding alkali chloride has been discussed by the I.G. Farbenindustrie.[31] The hydrochloric acid resulting from the reaction is removed by distillation in steam under reduced pressure. A further patent for the direct production of alkali nitrates by passing dry oxides of nitrogen over moist potassium chloride is due to C. W. Whittaker and F. O. Lundstrom.[32]

An interesting and important contribution to the principles which underlie the separation of sodium nitrate from Chile deposits has been published by A. Graziadei.[33] The study relates especially to the systems sodium-nitrate-sodium-chloride-water and sodium-nitrate-sodium-sulphate-water.

Miscellaneous Nitrogen Compounds

The use of alumina as a catalyst for the formation of hydrocyanic acid has been discussed by W. Fuchs and H. Verbeek[34] in connection with the production of this body by the interaction of ammonia with carbon monoxide. The most suitable catalyst was prepared by precipitating an aqueous solution of aluminium nitrate with ammonia and drying the precipitate at 100°. The dried alumina shattered into smaller fragments on being wetted; and shattering in the presence of a suspension of zirconium hydroxide or of a solution of zirconium nitrate was found to produce an excellent catalyst for the required reaction. In a typical experiment at 700°,

[13] " J. Chem. Ind. Russ.," 1935, **12**, 279; ex " Brit. Chem. Abstr.," B, 1935, 723.
[14] " Acqua e Gas," 1934, **23**, 47.
[15] " Chem. Weekblad," 1935, **32**, 186.
[16] Brit. Pat. 423, 397.
[17] Brit. Pat. 419,844.
[18] U.S. Pat. 1,957,244.
[19] " J. Chem. Ind. Russ.," 1935, **12**, 486; ex " Brit. Chem. Abs.," B, 1935, 801.
[20] Brit. Pat. 434,622.
[21] " J. Ind. & Eng. Chem.," 1935, **27**, 562.
[22] " J. Appl. Chem. Russ.," 1934, **7**, 1,339; ex " Brit. Chem. Abs.," B., 1935, 402.
[23] " J. Ind. & Eng. Chem.," 1934, **26**, 1,287.
[24] " Ukrain. Chem. J.," 1935, **10**, 271.
[25] " Compt. rend.," 1934, **199**, 869.
[26] U.S. Pat. 1,948,968.
[27] Brit. Pat. 418,916.
[28] 71st " Ann. Report on Alkali, etc., Works," 1934, 33.
[29] U.S. Pat. 1,964,158.
[30] Brit. Pat. 422,165.
[31] Brit. Pat. 415,660.
[32] U.S. Pat. 1,965,400.
[33] " Chim. et Ind.," 1935, **33**, 1,307; **34**, 29.
[34] " J. Ind. & Eng. Chem.," 1935, **27**, 410.

a yield of 56 per cent. of hydrocyanic acid was obtained. The time of contact is short, namely, of the order of a second. Of other publications dealing with hydrocyanic acid, mention may be made of an interesting study of the determination of residual hydrocyanic acid in stored products (cacao, wheat, tobacco, etc.) previously fumigated with this body.[35] The use of small quantities of sodium sulphite, according to proposals by C. S. Marvin and M. Walker, in order to prevent polymerisation of hydrocyanic acid during manufacture,[36] may also be noted.

The manufacture of cyanides is discussed in several patents. P. J. Carlisle and C. Dangelmajer[37] have described the preparation of calcium cyanide by the action of liquid hydrocyanic acid on calcium oxide suspended in ether. On the gradual addition of small quantities of water, calcium cyanide is precipitated. Reference may also be made to a patent of A. D. Macallum,[38] which deals with the manufacture of sodium cyanide by the passage of anhydrous hydrocyanic acid over sodium carbonate at 420°.

Conditions for the production of maximum yields of urea from ammonia and carbon dioxide have been discussed by B. A. Bolotov and A. N. Popova.[39] Drying the carbon dioxide and the use of a slight excess of ammonia in conjunction with a long time of contact were conducive to a high yield. Urea plastics, formed by the condensation of urea with formaldehyde, with or without the addition of thiourea, have been reviewed by K. M. Chance.[40] The paper also discusses the production of thiourea.

In conclusion, reference may be made to an interesting paper by R. O. E. Davis, W. Scholl and R. R. Miller[41] on the manufacture of ammoniated peat. The process of simple ammoniation is combined with that of urea formation. The peat is treated with ammonium carbamate, prepared from carbon dioxide and ammonia, and autoclaved for several hours at about 180°. If the urea content is maintained below 60 per cent., the peat retains its friability even under humid conditions.

[35] O. F. Lubatti, "J. Soc. Chem. Ind.," 1935, **54**, 275T.
[36] U.S. Pat. 1,950,899.
[37] U.S. Pat. 1,950,879.
[38] U.S. Pat. 1,966,253.
[39] "J. Chem. Ind. Russ.," 1934, **10**, No. 9, 32; ex "Brit. Chem. Abs.," B., 1935, 12.
[40] "Chem. and Ind.," 1935, **54**, 102.
[41] "J. Ind. Eng. Chem.," 1935, **27**, 69.

National Federation of Paint Manufacturers

Increasing Membership Roll

A STEADILY increasing membership during the year is an encouraging sign of the growing recognition of the important position which the National Federation of Associated Paint, Colour and Varnish Manufacturers occupies in the life of the industry to-day. The record of the past year's activities is convincing proof of the utility of such a central organisation, which has so many more facilities for dealing with the problems that are common to the industry as a whole than has the individual manufacturer.

A measure of success has again been achieved in the matter of tariffs, copal gums having been added to the Free List as a result of persistent effort by the Federation in face of what seemed at one time to be overwhelming odds. Free importation of these gums, which are very important ingredients in the manufacture of paints and varnishes, must be of considerable benefit to the users. The Federation, together with other consuming trades, has also strongly opposed an application by the National Seed Crushers' Association for an increase in the duty on linseed oil, the result of which is not yet known.

Light Hydrocarbon Oils Tax

The light hydrocarbon oil tax has been tackled with more than customary vigour. A joint memorial was sent to the Chancellor of the Exchequer in April by the interested trades, and this was followed up by an intensive campaign to obtain support to an amendment to the Finance Bill, allowing a rebate of 7d. per gal. from the duties payable on light hydrocarbon oils when used for other than transport purposes. The written support of 150 Members of Parliament, headed by the Rt. Hon. Major J. W. Hills, was obtained in this way. The Chancellor's proposal to tax heavy oil used for transport purposes and to exclude it when used for industrial purposes gave the opponents of the light hydrocarbon oil tax a valuable talking point which they used to good effect. Although the Chancellor would not accept the amendment, there are no signs of discouragement on that account among those who have persistently opposed this tax since it was first imposed in 1928, and another strong offensive is being prepared for next spring.

The industry can claim to be fortunate in having secured exemption for its materials from the provisions of the Poisons Act and Poisons Rules by recommendation of the Poisons Board in its report which was published in May. This was not achieved without some effort, an *ad hoc* committee appointed by the Federation having previously made a close examination of the position and submitted a memorandum to the Poisons Board setting forth the industry's views in this matter.

The Research Association of British Paint, Colour and Varnish Manufacturers, which was originally formed by members of the Federation, has been working under substantially increased Government grant conditions and subscriptions from members during the past year. Work on the extension of the existing buildings was commenced in March, and is practically completed. The new buildings will provide six additional laboratory rooms as well as office and library.

Joint Industrial Council

The Joint Industrial Council for the industry, to which the Federation is a party, reports a period of more settled conditions than have been evident for several years. Employment and wages in the industry have remained stable, and a measure of confidence has been restored among both employers and employed which cannot but be conducive to progress. The export trade is still fighting for its existence, and it could hardly be said with any justification that conditions have improved, except perhaps in the case of trade with India, which improvement is attributed partly to the Japanese having increased their prices, and partly to the irregularity in quality of their products.

The co-operative advertising campaign launched by the Paint Marketing Council in 1934 has been continued during 1935. Confidence in the good work it is doing is strengthened by the fact that unemployment among house painters has been reduced from 19.1 per cent. in 1933 to 12.7 per cent. in 1934 and to 10.7 per cent. in 1935. On every side there are encouraging signs that more paint is being used, and there seems to be no reason why the unemployment figures just quoted should not continue to improve and be reflected in other directions. Next year is the last of the three years' campaign originally envisaged, but, in view of the success that has attended its efforts so far, the Council may think it worth while continuing its activities after the end of the three-year period, provided it is assured of sufficient financial support.

The Work of the Public Analyst, 1935

By EDWARD HINKS, B.Sc., F.I.C.

Mr. Edward Hinks, Public Analyst for the County of Surrey.

FEW affairs in the work of the public analyst can be confined within the limits of a single year, so that in this review reference may properly be made to previous years and even an anticipatory excursion made into the future.

The public analyst derives his name from an Act of Parliament. Under that Act he is an analyst of food and drugs. Further than that he is often official agricultural analyst under the Fertilisers and Feeding Stuffs Act, analyst to water boards, river boards, etc. Particularly when a whole-time officer he may be called on for analyses for coroners and the police: he is often a gas examiner and in some areas he is a bacteriologist: frequently, too, he is consulted by his authority upon specifications and contracts for stores. It is a curiosity arising from the line of evolution of local government that the chemist to the London County Council, though agricultural analyst for the county, is not a public analyst. With such a range of work, public analysts can successfully operate only through collaboration with other analysts: the writer is glad to have another opportunity of acknowledging the indebtedness of public analysts to the "other analytical chemists" with whom they are united in one Society. The formation, this year, of a Scottish Section of the Society of Public Analysts is also recorded with pleasure.

Food Standards

The Departmental Committee on the Composition and Description of Food reported in March, 1934: its report may be summarised as finding that something, but not too much, must be done. In 1935 we have had, in the Annual Report of the Chief Medical Officer of the Ministry of Health, what may be regarded as a forecast of the action that will be taken by the Ministry. The Chief Medical Officer says "no general rule can be laid down as to standards. Each case must be considered strictly on its merits. A general system of standards should not be instituted merely because it will confer commercial or industrial advantages. The consumers' interest must come before everything . . . "it is clear that the framing of a satisfactory schedule of standards is no light matter." Assuredly this is so. One thing is certain—the establishment of standards will tax the ingenuity of the analyst.

It has rightly been argued that standards should not be established unless there are methods of analysis available for testing concurrence with those standards. On the other hand, for complex articles, and most foods are complex, methods of analysis are not likely to be evolved until the necessity for them exists. Strict adherence to these two premises must sometimes lead to an impasse: one cannot wait indefinitely upon the other: the working out of methods of analysis for a particular article for which it is desired to make a standard is no light matter either. As regards limits of metallic impurities, the Chief Medical Officer is of opinion that, in the absence of precise knowledge of what may or may not be injurious, "the soundest course to pursue is to limit the amount of the foreign substance in question to the smallest that can be achieved in practice."

This is the position at present. We must wait till 1936 and perhaps longer to see how it develops.

Severe antimony poisoning has occurred several times since 1928 through the use of enamelled ware containing antimony. Dr. Monier-Williams, chemist at the Ministry of Health, investigated the whole matter of antimony enamels and his report, issued in 1934, concluded that total prohibition of antimony might be in the best interests of the public and the trade: no such prohibition has made its appearance so far. J. H. Coste and D. C. Garratt ("Analyst," April, 1935) recount how they have arrived at a specification for resistance of enamelled hollow-ware to attack by 0.5 per cent. citric acid solution and record a marked improvement in the quality of the hollow-ware supplied to the London County Council.

Aluminium with probably less reason has received publicly more attention. It also has had its report from the Ministry of Health (1935). The aluminium controversy has provided some wild statements, excusable only, if at all, in that they were based upon equally wild analyses, which only goes to show that in matters of public importance analysis, even for light elements, should not be lightly undertaken.

Colouring of Food

Important points have been raised by some Food and Drugs Act cases in Buckingham, Northamptonshire and Oxfordshire. In one sense, colouring matter was incidental; in another, it was of the essence of the case. The articles in question were chocolate Swiss rolls, the sponge portion of which was found by the public analyst to contain from about 1 per cent. down to 0.1 per cent. of dry fat free cocoa matter, the prosecution contending that there should be not less than 4 per cent. It is difficult to put in a sentence the defendants' contentions, but they were substantially these, that no standard existed, that articles such as those complained of had been sold without complaint for many years, that they were liked and bought by the public, even that there was no necessity for the presence of any cocoa at all so long as the roll had the appearance and flavour of chocolate. Convictions were recorded in all cases and finally the 4 per cent. standard seems to have been accepted.

Some difference of opinion as to the proper proportion of cocoa is to be expected, but there can be little doubt that a purchaser would refuse an article such as those described above unless it were coloured to look like chocolate. The public's appreciation of flavour is more difficult to judge, but it would seem likely that a colour like that of chocolate and a vanilla flavour together convey the suggestion of chocolate. Here then is the significance of these cases—a colouring matter has been used in place of food material, the very food material that gives the name to the article.

Professor Drummond remarks upon "the inability on the part of man to select instinctively those foods which are best suited to his nutritional requirements." Perhaps an appetite for highly-coloured food is the last remnant of that instinct to the loss of which Professor Drummond refers, for vitamin potency is in many instances related to colour. Colour has long been used for decorative purposes, but when colour takes the place of a main or subsidiary food material, as it did

in the Swiss rolls, as it does so frequently in fruit wines and cordials, as it does when a yellow dye conveys the impression of egg though no egg is present, then a different situation arises. Shall brown bread be of the substance of white bread, but coloured? Shall a dyestuff take the place of tomato? Such extensions of the use of food colours are a peril to the consumer. And what of the "artificial ripening" of fruit, whereby the appearance of ripeness is attained without the other attributes of ripeness?

Cryoscopy

Extended use has been made of the freezing point of milk as an indication, and a measure of the amount, of added water. The cryoscope that has been most largely used in this country is that devised by Hortvet: a constant degree of supercooling is employed, a constant temperature difference between the cooling bath and the apparent freezing point, and very limited and controlled stirring are prescribed: no supercooling or heat transference corrections are applied. Clearly this procedure does not give the "true" freezing point, if indeed any method depending upon the freezing of a supercooled milk can give it. Equally clearly, if results by different observers are to be comparable, identical procedure should be adopted. J. R. Stubbs has this year given in the "Analyst" an interesting series of papers embodying a study of heat transference and other effects in the Hortvet, a modified Hortvet and the latest Monier-Williams cryoscope. The Council of the Society of Public Analysts and Other Analytical Chemists in 1933 reviewed the merits of the various forms of apparatus at that time available and the procedures employed therewith, and for administrative purposes recommended the Hortvet.

An Empire Marketing Board Committee had also been considering this matter. On the expiry of the Board, this committee ceased and, to cut a long story short, the above-named Society has this year convened a committee to report. This committee will have the benefit of the work of the E.M.B. Committee and is composed partly of the same personnel. The outcome of this committee's report is awaited with interest, for feeling has on occasion run high over this cryoscopic test. It is to be hoped that the committee's findings will bring a reasonable degree of satisfaction to all concerned, with perhaps some slight regret at the passing of an interesting and stimulating controversy.

Uniformity of Methods of Analysis

To the sixteen reports issued under this scheme there have this year been added (1) the determination of unsaponified fat in soaps, and (2) the determination of lead (in food colours).

I.C.I. Capital Reduction Scheme

Judge's Reasons for Approval

IN the Chancery Division, on December 20, Mr. Justice Eve gave his reasons for the confirmation, on November 13, of a capital reorganisation scheme by Imperial Chemical Industries, Ltd. The scheme involved a reduction of the capital from £95,000,000 to £89,565,859. The petition was opposed by a committee representing 13,296 holders of 4,435,521 deferred shares, who alleged that the scheme was "unnecessary and uncalled for, as not a single penny of capital had been lost."

Mr. Justice Eve said that no part of the large reduction of £5,434,141 was required for replacing capital which had been lost, or was unrepresented by available assets. Nor did it involve the payment to any shareholder of the paid-up capital of the company. The reduction was to be effected by cancelling paid-up capital to the extent of 5s. per share on each of the 21,736,564 deferred shares, and by reducing the nominal amount of each from 10s. to 5s. The amount representing the reduction was to be carried to a special capital reserve and was subject to an undertaking by the company that no part of it should be distributed as dividend. No want of good faith, no coercion or over-reaching on the part of the company or its directors had been suggested.

No one had attacked the scheme as being one to which no reasonable man could be expected to give his support. The reduction was an integral part of a scheme for the simplification of the capital by readjusting the respective rights of the ordinary and deferred shareholders, and for amalgamating their shares into one class. It was never seriously suggested that the burden of the reduction was not rightfully imposed on the shares standing last on the rota for dividend distribution. The substantial question on which the shareholders were divided was how many deferred shares were to be given in exchange for one ordinary share. He could not recall any criticism directed to any ambiguity in the board's circular to shareholders. No one had said he was misled by it.

The court was entitled to conclude that the company and its shareholders would act upon the lines contemplated by the resolutions unless it could be shown that the majority resolutions had been obtained by misrepresentation, concealment, chicanery or deceit. No such case had been advanced at the hearing. Indeed, from the first it was disclaimed. In those circumstances he had no jurisdiction to refuse the company the order asked for. The shareholders, including the deferred shareholders, had, by very substantial majorities, decided that the bargain was acceptable. The opinion of the deferred shareholders was that the exchange ought to be on the more liberal basis of two to one, and was founded, to a large extent, on the assertion that the company had been gradually accumulating large reserves of undisclosed profits, and that the day was fast approaching when these would be distributed, thus compensating the deferred shareholders for meagre dividends in the past.

The board was satisfied that the anticipated increase in the profits to justify the retention of the deferred shares had not materialised. The evidence absolutely disposed of the suggestion that there existed undisclosed reserve funds or hidden undistributed profits. There was no suggestion of any misrepresentation or misconduct on the part of the company. He did not accept the view that it was incumbent on the directors to disclose in the circular their respective holdings in ordinary and deferred shares. It was not suggested that anybody voted in the wrong class. Indeed, the contrary was proved, and it was impossible to hold that the bodily presence in the room where the meetings were held of persons who belonged to other classes invalidated the meeting.

Mr. Justice Eve made an order confirming the scheme.

OFFICIAL statistics of French alcohol production for the 1934 1935 alcohol season are as follows: 1934-1935 season (October 1, 1934—September 30, 1935)—5,772,138 hectolitres; 1933-1934 —4,043,003 hectolitres. Total production for the first nine months of 1935 amounted to 2,466,124 hectolitres, compared to 1,400,495 hectolitres for the first nine months of 1934, an increase of 1,065,629 hectolitres in 1935. Total stocks at the end of September were 3,333,384 hectolitres, as compared to 2,757,510 at the same date last year, an increase of 575,874 hectolitres; however, at the end of August this year statistics had shown a decrease, totalling 3,783,118 hectolitres.

The Year's Progress in Solvents and Plasticisers

By THOS. H. DURRANS, D.Sc., F.I.C.

Dr. T. H. Durrans.

PROBABLY the most outstanding feature of the past year's progress in the production, use and science of solvents is the manufacture for the first time in England on a commercial scale of decahydro naphthalene at a price which permits its use industrially. This substance has been made for some years on the Continent, but the high price of the imported material hitherto available has prevented its extensive use as a solvent in the paint and varnish industry. The English product is the fully hydrogenated substance, decahydro naphthalene, and an investigation of its properties and adaptability for paint and varnish manufacture has been made by the Research Association of British Paint, Colour and Varnish Manufacturers. Decahydro naphthalene for which the name "Dec" has been chosen, seems to have many of the desirable properties of turpentine and is a solvent of exceptional range for varnish resins.

The "long range" research noted last year continues actively, not only in this country and in the United States, but also in Russia and Japan. Investigational work on solvent production from available raw materials such as petroleum and producer gas is being undertaken in the latter countries along lines hitherto confined to England, the United States, and Germany. The active competition of Russia and Japan in the solvents market is probably not far distant. Among other investigations we find Japanese attempts to synthesise low boiling paraffin hydrocarbons and olefines from carbon monoxide and hydrogen co-ordinated with the synthesis of methyl alcohol by means of gas-phase reactions using zinc chromite catalyst, yields of 90 per cent. being obtained. The Russians record attempts to synthesise methyl and other aliphatic alcohols up to amyl from water gas under high pressure. Work is also being done in Japan on the production of decahydro and tetrahydro naphthalenes.

Production of Solvents from Petroleum

The production of solvents from petroleum as the original raw material is receiving greater attention, but it is interesting to note that the use of coal for the preparation of similar products is now projected. Two instances of the use of water gas are recorded but another interesting attempt is that of preparing propylene from methane and carbon monoxide by passing the mixed gases over glowing pumice under very high pressure: so far the yields are but small. Water gas is thus a possible source for the production of iso propyl alcohol and acetone. Methane and carbon monoxide have also been used to prepare alcohols by passing the gases mixed with air into boiling water, containing oxides of copper, lead, chromium or zinc, and ethyl and higher alcohols have been prepared from water gas by passage over the ferrates of alkali or alkaline earth metals under high pressure at 250° to 350° C.; copious yields of the alcohols are said to be obtained. Use has been made of coal gas for the production of chlorinated solvents—the chlorination is carried out by passing coal gas and chlorine into a solution of a catalyst such as bismuth, tin or antimony chlorides in di, tri- or penta-chloro ethane.

The isolation of ethylene and other olefines from coal gas has hitherto been a matter of great technical difficulty, but an ingenious method has been devised for extracting the olefines from cracked petroleum gases and may be applicable to coal gas. This method consists in a variation of the cuprammonium absorption process in which non-volatile hydroxy alkylamines, such as propanolamine, are used in place of the volatile ammonia—the absorbed olefines are subsequently recovered by heating the cupro hydroxy alkylamine solution under diminished pressure. Much work has been done on converting olefines into useful solvents. One example is that of the conversion of olefines and dienes into nitrocellulose solvents, having a higher boiling range than that of the original hydrocarbon, by treatment under pressure in the presence of carbon-monoxide and steam with catalysts, such as nickel, iron, zinc and vanadium oxides at 20° to 350° C. A similar procedure is that by which methyl propionate is prepared involving the passage of ethylene, carbon monoxide and methyl alcohol with a trace of ammonium chloride over activated carbon at 325° under 700 atmospheres pressure. The use of saturated hydrocarbons and olefines for the preparation of alcohols continues to engage attention both as regards the improvement of known processes and the discovery of new methods. Low boiling hydrocarbons have been oxidised to alcohols by passage with oxygen under high pressure over catalysts which are capable of forming carbides such as silver, platinum and steel, or over silicates such as clay at 260° to 600°: while cadmium phosphate promoted with barium phosphate has been found to catalyse the hydration of ethylene with steam at 100° to 300°. The degree of conversion is, however, small.

Absorption and Hydrolysis

Several modifications of the processes for producing ethyl and secondary alcohols from olefines by the sulphuric acid absorption and hydrolysis method have been recorded. One method of absorption consists in refluxing an oil containing olefine in a packed tower down which sulphuric acid is passing. The more volatile and less easily absorbed olefines come into contact with the fresh acid at the top of the tower, and the less volatile, more easily absorbed and more readily polymerised olefines come progressively into contact with the partly saturated acid as it passes down the tower. A new method for the hydrolysis of olefine saturated acid consists in passing this, diluted with an equal volume of water, down a packed column heated to 125°-130° at the base. Alcohol and ether pass away at the top with excess of olefine; the ether and alcohol may be isolated by fractional condensation and the olefine returned with or without the alcohol to the circuit; the acid passes from the bottom of the column in a concentrated form. A direct method for preparing alcohols and ethers from olefines is that of passing ethylene or propylene with steam through 72 per cent. sulphuric acid at 150° under pressure at a rate at which the olefine is only partly esterified, the excess passing away with the ether and alcohol formed in the process.

An original method for preparing *n*.propyl alcohol con-

sists in passing the ring oxide methyl ethylene oxide—which can be obtained from 1.2 dichloro propane by the action of alkalies—with steam over aluminium oxide at 275°, the product from the process being subsequently hydrogenated. Methods for the production of ketones have also received attention. The yield of acetone from the well-known process involving the passage of alcohol over an iron oxide catalyst has now been increased to 88 per cent. by promoting the catalyst with nickel or cobalt. Acetone has also been produced from acetaldehyde by treatment after dilution with neutral gases, with promoted metal oxides of Groups III and IV at 400° to 500° C., while the conversion of secondary alcohols to ketones by means of a brass catalyst at 370° to 430° in the absence of oxygen is recorded.

It has been found that the passage of ethyl alcohol over the mixed chromites of iron, nickel, copper and cadmium at 380° and under 200 atmospheres pressure leads to the formation of ethyl acetate, while glycerine dropped on to copper chromite at 240° to 260° has been found to give good yields of acetol, a pleasant smelling solvent for cellulose nitrate boiling at 146°.

Biological Processes

The production of *n*.butyl alcohol by biological processes has been the subject of several patents covering the use of new strains of bacteria having morphological and biochemical characteristics different from those previously described, such as B.butacone and various strains of the clostridium group: by means of the latter yields of solvents can be obtained ranging from 28 to 36 per cent. on the sugars of molasses and consisting of 68 to 70 per cent. of n.butyl alcohol, 26 to 32 per cent. of acetone and up to 6 per cent. of ethyl alcohol.

Advances have been made in the methods for the production of glycol ethers. One new method has been described for producing ethyl glycol in which ethyl alcohol and ethylene oxide are caused to combine by passage at 80° over hydro silicates acidified to a pH of 2.3—a yield of 80 per cent. is claimed. Substituted glycol ethers have been made from the so-called " tertiary " olefines by converting these to the halohydrines by means of hypochlorous acid, then forming the ring oxides by treatment with alkali and condensing them with alcohols. Two new solvent ethers produced in this manner are 2 methoxy 1.1 dimethyl ethanol B.P. 142°, and 2 ethoxy 1.1 diethyl ethanol B.P. 148°. Higher glycol ethers have also been prepared by similar methods from simple glycol mono ethers: thus bis(2 methoxy ethyl) methylene ether has been prepared from methyl glycol.

Patents which Hinder Progress

Among the large number of plasticisers which have been the subjects of patents during the last year, we have further additions to that never-ending class consisting of the esters arising from the combination of poly-basic alcohols and poly-basic acids with each other and with mono basic alcohols and acids. Most of such and similar patents seem entirely to lack inventive merit, the reactions being quite obvious to any competent chemist, and the fact that patents of this type are granted leads to the supposition that either our patent law or the administration of it is bad—it appears that the position in the United States is even worse. We see patents granted for the mere esterification of a well known alcohol by a well known acid. Such patents confer no real protection to the patentee and are a hindrance to general progress. It does not appear to be realised that esters and ketones of almost any type can be used as plasticisers provided they possess the necessary properties of low volatility, stability and miscibility.

Among plasticisers worthy of special notice are the partly benzylated sugars such as sucrose, dextrose and glucose—the benzoic esters of these sugars are solids or viscous amber coloured liquids, insoluble in water but miscible with the usual cellulose ester solvents. These esters, unlike the acetylated sugars, are said not to reduce the tensile strength of cellulose ester or ether films, although they are not directly compatible with the former: they are probably of most interest in connection with ethyl and benzyl cellulose.

Glyceryl tricrotonate is an interesting new substitute for triacetin and is claimed to be a plasticiser for cellulose acetate and ethyl cellulose. It is possible that plasticisers of this type may oxidise or polymerise on exposure in films. Such substances offer a valuable field for exploration. Crotyl phthalate and similar esters of unsaturated alcohols and esters of benzoylacrylic acid may also come into this category. A plasticiser of the glyptal type, which is said " to promote the rapid polymerisation of cellulose nitrate to its difficulty soluble or insoluble state " and which is said to improve the weathering properties of cellulose nitrate films, is prepared from unimolecular proportions of diethylene glycol and phthalic anhydride by heating to 110-150° until the acid value has fallen to 112. Another substance of the glyptal type is that obtained by the half esterification of phthalic anhydride with glycol and then esterify the remaining carboxyl group with butyl glycol.

A new class of plasticiser consists of a polyvalent metal salt of a ketonic carboxylic acid such as zinc *sec*-amyl benzoyl-o-benzoate and aluminium p.cymoyl-o-benzoate. These substances, not being esters, do not hydrolyse and they differ in this respect from the metallic salts of the alkyl half esters of phthalic esters described in 1930. They can be used in cellulose nitrate films in proportions up to 300 per cent. and such films are said to form good coatings for sanding and finishing and as filling coats.

The Pharmaceutical Society

Arrangements for New Headquarters

THE main concern of the Pharmaceutical Society during 1935 has been the setting up of machinery for bringing the Pharmacy and Poisons Act, 1933, into full operation. The provision of the Act, whereby all pharmacists by virtue of registration became members of the Society, came into operation on January 1, 1934, but during 1935 preparations have had to be made for the setting up of a register containing the addresses of the 14,500 premises which, on January 1, 1936, must be registered in a new register.

In May, 1935, the Poisons Board presented its report to the Home Secretary and recommended substantial alterations in the poisons legislation which were to be effected by the Poisons Rules. Among other controversial provisions, the Poisons Rules provided for the recognition of certain limited classes of chemical qualifications for those persons who were to be entitled to supervise the manufacture of pharmaceutical preparations containing poisons. These proposals were the subject of strong representations to the Home Secretary by the universities and by the British Association of Chemists. The statutory disciplinary committee under the Act prepared its Regulations and Rules of Procedure, which were approved by the Privy Council during the year. On January 1, 1936, it will be armed with its full powers, which include the power of removing the name of a pharmacist from the register and of disqualifying a corporate body from practising pharmacy. The membership of the Society on January 1, 1935, was 22,111.

During the year original investigations have been carried out in the various research departments connected with the Society's college. In particular, an elaborate investigation of the vitamin content of the edible vegetables of Ceylon has been undertaken as part of an economic survey, which is being conducted by the Government of Ireland.

Two awards have been made by the Society during the year. The Hanbury Medal for high excellence in the promotion and prosecution of original research in the natural history and chemistry of drugs was awarded to Dr. F. Pyman; the Harrsion Memorial Medal to Professor A. Smithells.

The development of the Society's activities has been greatly handicapped by the limited accommodation in their present house and arrangements are now actively in hand for the erection of new headquarters in Brunswick Square.

Annual Reviews from the Societies

Newcastle Chemical Industry Club

Need for Funds

DR. T. J. DUNN, F.I.C., was again elected president of the Newcastle Chemical Industry Club this year, but, unfortunately, was prevented from taking a very active part owing to a serious operation from which he has now happily recovered. Mr. H. Dunford Smith, M.Sc., chairman of committee, has, as usual, carried out his duties in a most conscientious manner.

Among the lectures delivered to members was one of outstanding interest on "Photography," delivered with great ability by Dr. L. A. Sayce, of Armstrong College. The lecture covered the history of the science, and a summary of the latest improvements which have been introduced in the last few years.

Owing to the prolonged industrial depression, the financial support of the Club's library has been somewhat meagre, and funds are urgently needed to keep it more up to date with recent publications. The library is now well organised, owing to the strenuous work of Mr. P. D. Scott, M.Sc., and Mr. E. B. Davies.

British Plastics Federation

The Return of Prosperity

IN these days of co-operative trading and industrial combines the individualist has little chance of riding the storm of competition. With protection against dumping and with scientific methods of production and distribution our country from a nation of shopkeepers has become a nation of manufacturers. None will deny that prosperity has returned. It is a healthy sign to see the growth of trade associations, as without some such central body it is impossible for the various interests of any one trade to be properly and successfully co-ordinated for the wellbeing of the industry as a whole.

Such a trade association is the British Plastics Federation, Ltd., covering every branch and interest of the plastics industry from the raw materials and plant to the distribution of the finished mouldings. How comprehensive it is can be judged from the following interests included in its membership: Casein, celluloid, raw materials, moulding powder, moulders, plant, tools, synthetic resin and varnish, laminated products, inserts, steel, distributors, Empire raw materials.

The Plastics Federation has provided opportunity for the separate interests to get together by forming sections for each branch of the industry, and already much good work has been accomplished by these sections. Where any problem arises which may affect more than one section, arrangements are made for joint meetings. One important function of the Federation which would not otherwise be possible is the drawing up and revision of technical specifications, involving collaboration with the British Standards Institution and Governmental departments. This work is carried out by highly qualified experts from the respective branches concerned. The Plastics Federation has for some years been entrusted by the Department of Overseas Trade to organise and superintend the plastics exhibit at the British Industries Fair. It has also staged this year an exceedingly interesting exhibit at the Royal Academy Exhibition of British Art in Industry, and arranged a collection for the Brussels Exhibition.

Recently in collaboration with a stores magnate an interesting and successful exhibition of moulded articles was arranged at a large store in Manchester where the public could purchase the articles from the stalls. This experiment was so successful that it will be repeated in several other large towns next year.

Society of Dyers and Colourists

Co-operation by Employers

PROFESSOR ARTHUR G. GREEN, F.R.S., F.I.C., was re-elected as president of the Society of Dyers and Colourists at the annual meeting held at the Dorchester Hotel, London, in March, 1935, at which meeting the honorary treasurer, Mr. H. Jennison, gave a very favourable report on the balance sheet for the year 1934, which included the Golden Jubilee celebrations of the Society.

The various sections of the Society held a large number of lectures during the period October, 1934, to April, 1935. The membership of the Society has considerably increased during the present year, and the same applies to subscribers to the "Journal."

Through the efforts of the president several large associations and firms have agreed to an arrangement whereby persons on their staff who join the Society as members have half their annual subscription refunded to them by their employers. Other associations have agreed to give an annual grant towards the funds of the Society, in order to improve the monthly Journal, which, under the editorship of Professor F. M. Rowe, D.Sc., F.I.C., and Mr. Ellis Clayton, F.I.C., has been greatly improved during the present year. The Golden Jubilee special volume has been very much appreciated, a large number of copies of this work having been sold in all parts of the world, and the Society has arranged for copies to be sold to students at the various universities and technical colleges at a reduced price. Special arrangements have also been made with libraries with respect to this publication, it being the opinion of the Council of the Society that this Golden Jubilee issue should be on the files of every library in the British Isles.

The "Colour Index," published by the Society, is still in great demand, over 2,700 copies having been sold, and a further reprint is now available. The work of the Fastness Test Committee on "Standardising the Methods of Testing the Fastness of Dyed and Coloured Materials" is now completed; the "Report of the Committee" for which there has been a great demand from all parts of the world, has been published by the Society.

The Ceramic Society

Notable Progress in Research Work

THE Ceramic Society during 1935 continued successfully its now indispensable task of ensuring the issue and distribution of the results of much valuable research on materials and processes of interest and importance to the members of one or more of its three sections—pottery, refractory materials, and building materials, respectively. In June, a large party of members, including prominent representatives of all the sections, toured Sweden and Denmark, visiting various industrial establishments. The hospitality and good feeling shown throughout to the visitors made a strong impression, which will long abide in their memories.

A feature of the year's activities is that a larger proportion of the contributions had a close bearing on practical problems met with in the factories, and this applies in outstanding measure perhaps to the Pottery Section. In that Section there were papers by E. W. T. Mayer on "Underglaze Colours," by Dr. Mellor on "The Brazing and Peeling of Glazes" and on "The Durability of Pottery Frits, Glazes, Glasses and Enamels in Service," by N. D. Wood on "The Manufacture of General and Domestic Stoneware," by A. Rigby on "Plotting Clays," by J. H. Latchford and B. J. Bell on "Pottery Printing," the former dealing with "The Engraving," and the latter with "Pottery Printing Paper" (which is a special variety made for this purpose), and by

C. D. Grimwade on "The Handling of Earthenware Casting Slip." Other contributions included "Mason's Ironstone China," by Mrs. Beardmore, "Silicosis—The Harmful Dusts which Cause it," by Dr. W. R. Jones, and the presidential address by Mr. A. E. Hewitt.

The Refractory Materials Section was responsible for the production of several papers relating to the "Burning of Magnesite," by Dr. Chesters and several colleagues, two papers (Parts I and II) entitled "Notes on the Texture of Refractories," by T. F. E. Rhead, "Action of Alkalies on Refractory Materials," by Clews and Green, "Experiments on Grading, Porosity and Permeability to Air of Silica Bricks," by Clews and Green, also "Refractoriness and its Determination," by the same investigators, and "The Effect of Water Content of Silica Brick Batches on Porosity," by T. R. Tyman and W. J. Rees.

Certain papers are in some degree of interest to all sections. The following were of this character. "Some Geological Factors affecting Clay Works," by Edgar Morton, "Deaeration of Clay," by John M. Willis, "Principles of Vibrating Screen Practice," by J. G. Turney, and "Promotion of the Drying of Clay by the Coagulating Effect of Acids," by H. H. Macey.

In the Building Materials Section a paper by A. B. Searle, entitled "Mile-Posts in Brickmaking," pleasantly recalled many points of interest, historically and otherwise. Some of the other papers mentioned have application to the manufacturing of bricks, as have also several more recent papers, which have not yet appeared in the Transactions of the Society.

Society of Glass Technology

Work of the Sections

DURING 1935 the Society of Glass Technology held eight ordinary general meetings, four in Sheffield and one each in Leeds, Liverpool, London and Stourbridge. The usual meeting in May was not held, as in that month the Society joined with the Glass Manufacturers' Federation in holding the Fourth Glass Convention. This convention was held at Folkestone from May 15 to 18, the convention president being Mr. Geoffrey L. Pilkington.

At the annual meeting in April, Mr. G. V. Evers, of Stourbridge, was succeeded as president by Mr. B. P. Dudding, M.B.E., A.R.C.Sc., F.Inst.P., of the research laboratories of the General Electric Co., Ltd., Wembley. Mr. F. G. Orme, O.B.E., C.I.S., was elected honorary general treasurer in the place of Mr. Dudding, while Professor W. E. S. Turner was re-elected honorary secretary.

In addition to meetings of the parent society, meetings of the three local sections of the Society were held throughout the year. These three sections are:—(a) *London.*—Hon. secretary, Mr. G. F. Adams, B.Sc., research laboratories of the General Electric Co., Ltd., Wembley; (b) *Midlands.*—Hon. secretary, Mr. G. W. Stuart, Stuart & Sons, Ltd., Red House Glass Works, Stourbridge; (c) *Yorkshire.*—Hon. secretary, Mr. A. Garstang, King, Taudevin and Gregson, Ltd., Cambridge Street, Sheffield 1.

Some 30 original papers and reports, as well as 1,100 abstracts of other papers, were included in the four numbers of the "Journal of the Society of Glass Technology" for the year. During the year the Council of the Society decided that after 1935 the "Journal" shall be published six times a year, instead of four times as hitherto.

In September the Society published its third monograph, namely, "Refractory Blocks for Glass Tank Furnaces," by J. H. Partridge, B.Sc., Ph.D. Previous monographs dealt with "The Constitution of Glass" and "The Analysis of Glasses, Refractory Materials and Silicate Slags." The various committees maintained their activities during the year, namely: (a) glass standards, (b) furnace, (c) refractories, and (d) form, design and process work. Early in the year specifications were published for (1) creosote fuel oil for use in glass works, and (2) sands for making colourless glass.

The Society suffered two notable losses by the deaths of two of its distinguished members, Mr. Walter Butterworth, M.A., J.P., of Manchester, and Dr. Otto Schott, of Jena, Germany. Mr. Butterworth was a past-president of the Society, an office which he held for three years. Dr. Otto Schott was an honorary member of the Society and a glass technologist of world-wide repute. The headquarters of the Society are at Darnall Road, Sheffield, 9. The hon. secretary is Professor W. E. S. Turner, O.B.E., D.Sc.

Micro-Organisms and Colours

Glasgow University Alchemists' Club

IN a paper on "Some Colouring Matters of Micro-Organisms" delivered to the Glasgow University Alchemists' Club on November 20, Mr. A. R. Todd said that although it is common knowledge that many micro-organisms are coloured, there has been, until recently, relatively little work done on the nature of the coloured substances they produce. Two benzoquinone derivatives have been isolated by Raistrick and co-workers from penicillium mould species, grown on glucose containing media. The purple methoxy-dihydroxy-toluquinone from *P. spinulosum* may arise from glucose by a relatively simple series of reactions: condensation with formaldehyde to yield a ketoheptose which is reduced, cyclised, dehydrogenated and methylated. Only one benzoquinone derivative (perezone) is known among the higher plants. Kögl has isolated from some higher fungi three diphenylquinones (derivatives of p-terphenyl), *e.g.*, brown polyporic acid (2:5-diphenyl 3:6-dihydroxybenzoquinone) from the shelf fungus *Polyporus nidulans.*

a-Naphthaquinone derivatives, which occur to some extent elsewhere in nature, have one representative in phthiocol (2-methyl 3-hydroxy-naphthaquinone) a yellow pigment from the tubercle bacillus. Kögl has discovered two phenanthraquinone pigments in fungi. Thelephoric acid from brown heath fungi is a trihydroxyphenanthraquinone carboxylic acid with an unsaturated side chain. It is remarkable that, although higher plants are capable of synthesising the phenanthrene nucleus (*e.g.*, morphine, etc.), there is no recorded case of a colouring matter of this group among them. Anthraquinone derivatives are of frequent occurrence both in higher and lower fungi. Among them may be mentioned emodin, known to occur in higher plants, and boletol (purpurin-*a*-carboxylic acid) both isolated by Kögl.

A Study of Related Organisms

What is probably the first real effort to study a complete series of related organisms has been made by Raistrick, Robinson and Todd, who examined practically all the known species of plant pathogenic moulds of the genus Helminthosporium. These organisms, which cause leaf stripe diseases in cereals and gresses, are frequently reddish brown in colour, and where coloured yield on hydroxyanthraquinone derivatives.

Carotenoids are of frequent occurrence among the micro-organisms being in many cases identical with those occurring elsewhere in nature, though some hitherto unknown members of the group have been described. Porphyrins occur in the lower micro-organisms, and it has been established by Fischer that certain yeasts are capable of producing coproporphyrin when grown on porphyrin free media. The purple sulphur bacteria produce a pigment of this group containing magnesium; it is similar to but not identical with chlorophyll. Related to these is the red tripyrryhmethane derivative prodigiosin from B. *prodigiosus.* Azines are represented by two members of the phenazine group from bacteria, and by lactoflavin (vitamin B_2) which occurs in yeast and various fungi.

The Voice of the Industry

A Retrospect of 1935 and a Glimpse of the Future

WITH the approach of the end of the year we recently invited our advertisers to tell us, each in a brief New Year message, something about the progress they had made during the past twelve months and what were their prospects for development in 1936. On the whole the replies we received were more optimistic than for many years past. Below we give extracts from these seasonable communications.

The British Drug Houses, Ltd.

DURING 1935 there has been abundant evidence of growing trade activity, reports The British Drug Houses, Ltd. In the fine chemical trade there have been many interesting developments and every prospect of more in the new year. There has, for instance, been a largely increased demand for 'AnalaR' chemicals both from buyers at home and abroad, the specifications published in "'AnalaR' Standards for Laboratory Chemicals" having been accepted by all who recognise the importance of purity in reagents used for scientific work. Micro-analytical methods have also found wide application in chemical and biological research and in the control of industrial processes; in the fourth edition of the "B.D.H. Book of Reagents for 'Spot' Tests and Delicate Analysis," published during 1935, the use of 67 organic reagents is described. The range of alkaloids manufactured in the B.D.H. works has been augmented by the production of ergometrine, the newly discovered water-soluble alkaloid of ergot. The discovery that mandelic acid is an extremely efficient urinary antiseptic when administered in the form of its sodium salt has led to the large-scale production of mandelic acid and sodium mandelate.

B. Laporte, Ltd.

During 1935 there has been a steady business in all products manufactured by B. Laporte, Ltd., and constant attention has been given to the improvement of processes and plants, particularly in connection with the manufacture of the barium range of products and the oxygen bleaching agents. The manufacture of ammonium persulphate has been successfully accomplished during the past few months. The outstanding development at the Luton works, however, is the success accomplished by the subsidiary company, National Titanium Pigments, Ltd., which is making considerable extensions to its productive capacity. Owing to the extension of the business of B. Laporte, Ltd., and its subsidiaries, it has been found necessary to construct new office premises. The erection of new laboratories has been decided upon, and the work will be completed at an early date. The erection of the new offices and laboratories releases a considerable building area, which will be devoted to improving the conditions in the factory for the workpeople by the provision of a new canteen and other amenities.

Bowmans (Warrington), Ltd.

As the only British manufacturers of technical lactic acid, Bowmans (Warrington), Ltd., report that trade in this product has been fairly good throughout this year, but, whilst the home trade has improved, export trade has slightly fallen off. This company also manufactures sulphonated oils, including castor, cod, neatsfoot, and olive, and various materials for the tanning trade.

British Tar Products, Ltd.

According to British Tar Products, Ltd., the past year has seen an all-round advance in the prices of practically all tar products, and in certain of the lighter products, such as toluol and xylol, the more recent increase in value has been accelerated by the Italo-Abyssinian war. Quite apart from the latter occurrence, however, the improvement has been quite normal and undoubtedly reflects a continued improvement in general trade conditions of the country. Confidence is shown by the willingness of many of the larger consumers to cover their requirements for the greater part of 1936. The recovery in the value of coal tar pitch would appear to have commenced after a long depression, and if this continues, along with the maintained firmness of creosote, the prospects for 1936 may be said to be favourable.

Boots Pure Drug Co., Ltd.

Steady progress in all production departments during 1935 is reported by Boots Pure Drug Co., Ltd. In particular, the plant for the manufacture of fine chemicals, including many products of clinical importance, has been working to its fullest capacity. A special building is now in course of construction at the Beeston factory to meet the growing requirements of fine chemical manufacture. Improvements effected in the manufacture of insulin-Boots have lowered production costs so that the consumer has benefited by a substantial reduction in price. Shortly after the discovery that mandelic acid was of value in the treatment of urinary infections, the company issued mandelic acid-Boots, and, later, sodium mandelate-Boots, which is more convenient in use as no preliminary neutralisation is required. Together with other manufacturers the company hopes that the feeling of confidence and increased stability in the country will be maintained in 1936 and that it will be necessary further to increase the staff, thus helping to reduce the number of those who are at present unemployed.

The Gas Light and Coke Co.

The past year has been marked by a steady revival in business and a general rise in values, reports The Gas Light and Coke Co., which distils over 32 million gal. of tar yearly. Intensive research has resulted in the preparation of road tar of great durability and perfect non-skid properties. A new carbolic plant has been installed to produce phenol of the highest purity and cresols of special boiling ranges. Plants have also been erected for the recovery of cyanogen and for the manufacture of prussiate of potash and of bronze blues. This means that the company is re-entering markets in which it was pre-eminent for many years. The prussiate is exceptionally free from impurities and is produced in small crystal form for easy handling and ready dissolving.

Sofnol, Ltd.

The past year has brought Sofnol, Ltd., increased business in all departments, no doubt due to the better trade conditions in most industries. Sofnol mixture for water softening, and Sofnol apparatus and reagents for water testing, are being used in an ever-increasing number of steam generating installations. The soda lime department has also been kept working at full pressure to meet demands. To cope with this increase in business, and to be able to meet still further the demands of its customers, the company has considerably extended its Greenwich works and has installed additional machinery. Further office and laboratory accommodation has also been provided and the company is looking forward to a still better year in 1936.

Henry Wiggin and Co., Ltd.

An important event in the past year's activities of Henry Wiggin and Co., Ltd., was the celebration of this company's hundredth anniversary—already referred to in the pages of THE CHEMICAL AGE. A development of particular interest this year has been the marketing of "K" Monel, an improved type of Monel metal. "K" Monel, however, possesses mechanical properties which cannot be obtained in a straight

nickel-copper alloy such as Monel metal. It can be rendered soft or hard by heat-treatment, although still retaining the characteristic corrosion-resistance which has given Monel metal such an important place in the chemical engineering field. Although "K" Monel is the result of twelve years' laboratory experiment it has been available to industry such a short time that its many possible applications in the chemical industry have not yet been fully explored. It has, however, proved to be of exceptional value in the form of valves and seats in pumps handling oil containing brines and sodium sulphide, where it has been found to outlast high alloy corrosion-resisting steels with a service life of 4 to 1 in its favour.

Monsanto Chemicals, Ltd.

During 1935 Monsanto Chemicals, Ltd., has carried out considerable extensions to its plant at Ruabon, North Wales. A synthetic phenol plant was completed and is now in operation, and, in support of this manufacture, sulphuric acid is now being produced by catalytic method at Ruabon. The company is now manufacturing phthalic anhydride, in a particular flake form specially suitable for the resin varnish trade. The phenacetin plant has been extended, and the rapid increase of sales indicates that the quality gives entire satisfaction. During the year the company has also extended its transport and storage facilities, large galvanised tank waggons with special facility for discharge, and considerable extensions to the warehouse, assisting in this direction. The early part of 1936 will see the production of sodium benzoate and benzoic acid, and other plans are already in hand for further developments later in the year. Volume of business shows still another advance, and includes an extension of the export trade and the opening up of many new markets.

General Chemical and Pharmaceutical Co., Ltd.

As should be the case with manufacturers of analytical reagents and general laboratory chemicals, the most fundamentally important work of the General Chemical and Pharmaceutical Co., Ltd., has been in the direction of increased purity of product, and the establishment of further improved analytical control at various stages of manufacture. Each year sees new products added to the company's already very wide manufacturing range, and 1935 has been no exception. A development of importance to the user has been the adoption of an improved screw-stoppered bottle with moulded cap as the standard package (in normal sizes) for Judex analytical reagents. Important new home and overseas contracts for reagents and laboratory chemicals have been secured during 1935, and it is satisfactory to state that in spite of the difficulties in many markets the company's export trade in 1935 was the best for the past 12 years. Whatever 1936 may have in store, the company stands on the threshold of the new year with large orders on hand, an increasingly wide clientele amongst the more critical users of laboratory reagents, and better equipped than ever before to handle the growing demand for its products.

Kestner Evaporator and Engineering Co., Ltd.

The Kestner Evaporator and Engineering Co., Ltd., has made continued progress and development in the many types of chemical plant in which they specialise. Keebush has supplied a much needed material of construction in many chemical industries, its principal uses being in connection with plant handling hydrochloric, acetic and sulphurous acids. The Kestner spray drier, well known in the preparation of food products in a powdered form, powdered tanning extracts and various chemicals, is now also well established in the soap industry and during the past year several installations have been completed. Considerable progress has been made in high temperature heating, both by fluid heat transmission and electric heating, and an interesting new development has been the application of the Kestner patent Merilene system in connection with the heat treatment of aluminium and other alloys for the manufacture of aircraft and other purposes. The use of electric heating has been considerably extended and a number of Isolectric patent heating plants have been supplied, in particular for the varnish industry for the heat treatment of linseed oil, and the production of synthetic type resinous materials. This system of heating has recently been applied for deodorising and similar high temperature work in connection with the treatment of vegetable oils for deodorising, polymerising, etc.

Johnson, Matthey and Co., Ltd.

During the past year there has been a steady increase in the demand for gold, silver and platinum and their associated products for use in various branches of industry, reports Johnson, Matthey and Co., Ltd. As a result, considerable research and experiment has been devoted to the industrial uses of the precious metals with a view to preparing the most suitable product for each particular requirement.

A notable example of the progress made during the past year is that with regard to silver solders. After a long period of laboratory research and workshop experiment, a range of silver solders has now been produced which includes a number of new alloys and appropriate fluxes suitable for a variety of applications where ordinary soft solders on the one hand, and brazing brasses on the other, are unsuitable. The fruits of this research have been enjoyed by members of a variety of trades, and in several cases brazing problems which have long existed have been solved by the application of one or other of these new alloys.

In spite of the increase in the price of fine silver, interest in Matthelytic silver plant is still evident, and inquiries are constantly received from all parts of the world in response to the information contained in the company's Publication No. 66 which describes this product. Since the issue of a publication describing Staybrite steel gauze there has also been a marked increase in the demand for this material, and several new applications have been found for it, particularly where sieves or strainers of strong non-corrosive material are required. Staybrite gauze of 200 mesh is now available.

Robert Bowran and Co. (1934), Ltd.

A satisfactory increase in the demand for protective and anti-corrosive paints and compounds is reported by Robert Bowran and Co., Ltd., who maintain that, despite the number of new protective materials now available, bitumen is still widely held in favour as a proved protector of iron and steel. The use of the palest bitumens obtainable, together with their careful blending with other ingredients, results in a list of bituminous products of almost limitless range. A new varnish and medium shop, introducing new methods of heating and heat control, and the installation of modern precision machines has meant an ability to cope with the greater demand and yet maintain, and even increase, the standard of excellence.

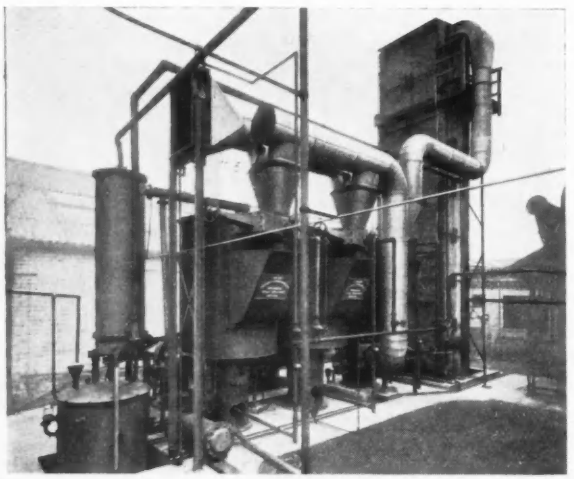
Kelvin Bottomley and Baird, Ltd.

Further apparatus for testing materials has been developed by Kelvin Bottomley and Baird, Ltd., during 1935. During the latter part of the year the company has been engaged in the development of the K.B.B.-Digby paint testing apparatus, and such apparatus can now be supplied to paint users and paint manufacturers. It enables the character of the paint film to be tested for resistance to breakdown and the record of such deterioration and breakdown can be provided in a visible form. In an alternative apparatus the effects of ultra-violet radiation on the paint samples is added, when desired, to that of the galvanic stress. Improvements have been made in connection with the Pneumercator remote liquid level gauges and many difficult problems, involving the indication of liquid levels and liquid quantities at a distance, have thereby been solved. A particular application of the Pneumercator gauges has been in connection with molasses which is stored in very large tanks for the purpose of the manufacture of alcohol, etc. The old method of determining

the quantity in the tank was to endeavour to sound it by a dip tape, then to make a measurement of the mean specific gravity, and from this data to obtain the weight of liquid in the tank. The difficulty, due to foam present on the surface of the molasses, and of determining the mean specific gravity caused this method to produce erroneous results. A Pneumercator gauge applied to such tanks and provided with a scale in weight reads the correct weight of molasses independent of changes in the specific gravity and takes the value of the foam into account in these readings and has, accordingly, displaced the old method of "dipping" the tanks. In the power houses of factories, the Pneumercator remote boiler water gauge has been widely applied to modern boilers with high steam drums, and also to waste heat boilers, which are often placed in awkward positions so that the steam drum gauge glass cannot be observed.

Sutcliffe, Speakman and Co., Ltd.

According to Sutcliffe, Speakman and Co., Ltd., the year 1935 has been a period of expanding trade. Considerable progress has been made with regard to solvent recovery plants in connection with the dry cleaning industry, plants having been installed for Martins (Dyers and Cleaners), Ltd., Jas.



Carbon Bisulphide Recovery Plant installed in connection with a large firm of rubber proofers. Recoveries range close upon 90 per cent. of the total carbon bisulphide used at these works.

Smith and Sons (Cleaners), Ltd., and in connection with The Burtol Cleaners, Ltd. The most outstanding plant supplied during the year was for G. and G. Whitehead, Ltd., of Lower Broughton, Manchester, the problem being the recovery of carbon bisulphide; this has beeen a particularly successful installation and has justified all expectations that were anticipated of it. A contract of particular promise—at the present time in the course of construction—is a large solvent recovery plant for David Moseley and Sons, Ltd., Ardwick, Manchester.

Staveley Coal and Iron Co., Ltd.

The improvement in trade which was noted last year by the Staveley Coal and Iron Co., Ltd., has continued, and the demand for chemicals indicates that most of the trades in this country are in a more flourishing condition now than they were twelve months ago. The most unsatisfactory market has been that for nitrogeneous fertilisers. The pitch market has suffered a considerable drop; this arises largely from the fact that the improvement in the iron and steel trades has brought about increased production. There are, of course, other factors in the situation, but as there are such large stocks in this country, the outlook does not look at all promising, in spite of the fact that there has recently been an advance in price. Export trade has remained difficult owing to the imposition of quotas and managed currencies. Japan continues to worry the British chemical trade in many directions by offers of larger quantities and an increase in the number of articles at cut prices. If British manufacturers are to have the feeling of security which is necessary for expansion of trade, a very close watch will have to be kept on Japanese trade and prompt measures taken for dealing with it whenever the necessity arises. The company is installing a plant for the manufacture of sodium chlorate.

Blairs, Ltd.

Success in some outstanding developments in design of plant for the chemical and food processing industries has been achieved during the past year by Blairs, Ltd. The vacuum band drying machine which they have recently designed and built embodies a number of unique features which greatly simplifies the production, at low temperatures, of material in powder or crystal form from various liquids. They have also, during the past year, obtained sole manufacturing rights for Kuhni patent rectifying and fractionating still plates. The development of these plates marks a definitely progressive step in the design of distillation plant, as by their application considerable saving in steam consumption is effected and the efficiency of still columns fitted with Kuhni plates is increased as compared with the efficiency of columns of other designs. A number of novel features have been embodied on the evaporators made by the company.

Carty and Son, Ltd.

Engaged in the vat-making industry, Carty and Son, Ltd., are in the happy position of being able to report that they have been working at high pressure throughout 1935. Chiefly responsible for this has been an exceptionally large contract for fermenting vessels and store vats for the new brewery at Park Royal. Being bound down to rigid time limits on this contract, the company's resources have been taxed to such an extent that it has not always been easy for them to serve all their good friends in the chemical industry with the usual promptness. They therefore offer their apologies for any shortcomings in this respect, and would like to take the opportunity of pointing out that, as the Park Royal contract is now drawing to a close, they are once more in a position to quote keenly competitive prices and prompt delivery. Throughout the chemical industry the use of wooden tanks and vats continues to grow, and an additional timber is being introduced for their manufacture, namely, Siberian larch.

Hathernware, Ltd.

Specialising in the production of high-class chemical stoneware, as distinct from the ordinary sanitary stoneware or earthenware, Hathernware, Ltd., have a research department engaged on developing various types of stoneware to meet the exacting demands of chemical manufacturers, namely, resistance to corrosion and freedom from contamination. During 1935 the company has successfully completed the production of bulk acid-storage installations, stoneware centrifugal pumps and exhauster fans, also pipe-lines for conveying corrosive liquids, whilst there has been an improvement in demand for their productions of white stoneware for pharmaceutical and food products plant.

The Thermal Syndicate, Ltd.

A satisfactory demand for Vitreosil (pure fused quartz and silica) ware, both for laboratory uses and chemical plant, is reported for 1935 by The Thermal Syndicate, Ltd. This company states that the manufacture of pure acids, especially colourless hydrochloric acid, is extending both at home and abroad, and Vitreosil is proving unbeatable for this work. During the year a direct fired Vitreosil sulphuric acid concentrator of high thermal efficiency has been introduced and has attracted world-wide attention. Developments in refractory materials include fused magnesia, which is of interest to the electrical industry on account of its high electrical resistance and relatively high thermal conductivity, and

pure alumina ware for laboratory work. The latter can be used up to 1,950° C. for investigations on fused metals and oxides, fused salts and other compounds to which it is highly resistant at high temperatures.

Wild-Barfield Electric Furnaces, Ltd.

The year 1935 has been one of remarkable interest so far as Wild-Barfield Electric Furnaces, Ltd., is concerned. The demand for electric furnaces and muffles has largely exceeded previous years. Special furnaces for stoving, kilning and other heat treatment processes have been in great demand. The majority of these are replacing existing gas and oil furnaces, and such replacements are invariably due to the greater uniformity of temperature and the ease and simplicity of temperature control. Added to this, electric furnaces on long period heating, such as carbons, etc., can be left to work night and day without any attention whatever, thus effecting considerable labour costs. Laboratory muffles have also been in greater demand than previous years, and numerous additional types have been standardised to meet the requirements of works chemists and others.

C. L. Burdick Manufacturing Co.

One interesting feature of the year's work reported by C. L. Manufacturing Co. concerns the introduction of a new recording hygrometer. On this instrument the chart on which the graph is to be traced is printed in rectangular lines, whereas the usual form which these charts take, both for hygrometers and barometers, is with curved lines for the time factor. This is made necessary if a long pivoted arm is used positioned at right angles with the clock. This new instrument has a pen which travels up and down in a straight line vertically: this mounting makes the graph more easily readable. The instrument also has a transparent casing and the entire chart is visible. Another improvement is a pen fed by capillary action from a small cup-shaped ink container, which so ensures a longer run without having to renew the ink. The company anticipates that several other inventions will be brought out in 1936, among them being an instrument for measuring the percentage of water in tea, tobacco, grain, etc.

Electromersible Motors and Pumps, Ltd.

During the past year Electromersible Motors and Pumps, Ltd., have been kept busy with the demand for their several different types of submersible motor pumps. Four pumps of the Salvage type were required by Sir William Arrol and Co., Ltd., for work on the Waterloo Bridge rebuilding scheme, each pump having an output of 700 gal. per minute to 80 feet. Three similar 6 inch pumps have been recently supplied to Bowater's Paper Mills, Ltd., for carrying out an extension of their wells. In the borehole submersible speciality a number of units have been supplied with varying lifts up to 420 feet and capacities up to 55,000 gal. per hour. A special feature of all these pumps is that they have no watertight enclosures to give trouble, or grease to contaminate the water. From the numerous inquiries for borehole pumps and work in hand this company anticipates a busy time during the coming year.

Haughton's Metallic Co., Ltd.

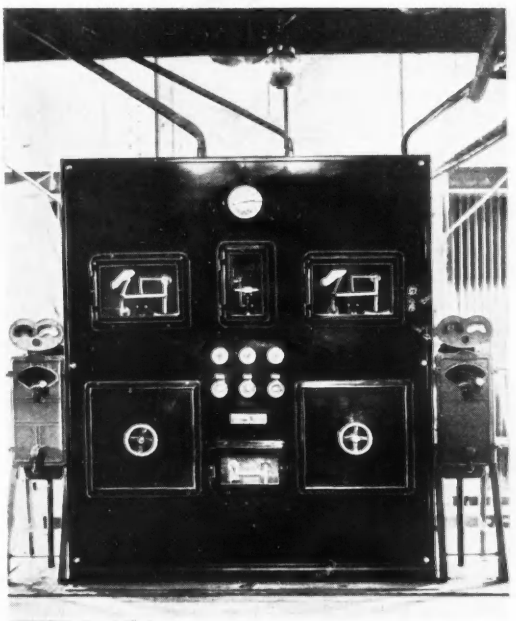
The new year is being eagerly looked forward to by the directors of Haughton's Metallic Co., Ltd., as there is every prospect of this seeing not only continued good trade in the chemical industries of the country, but a definite improvement on past years. Continued progress has been made during 1935 in research and in the improvement of Ironac acid-resisting iron for the chemical industry, in order to further demonstrate its widespread application for chemical plant. Some important installations of acid concentrating plant and acid condensing plant have been carried out with great success, not only in this country but also in India, Australia and the Colonies. In acid pumps, the company has successfully introduced a glandless type plunger pump for acids, constructed in Ironac metal. This pump seems to meet a long-felt want for dealing with acids in cases where a positive acting pump is desirable. For many years plunger pumps of any kind were found to be quite unsatisfactory, owing to gland leakages and the difficulty of providing any suitable form of packing to resist acids for any length of time. All this has now been superseded and pumps are furnished without glands and without packing. Whilst referring to acid pumps, it may be mentioned that the year 1935 has shown a very wide increase in the number of electric motor driven sets of centrifugal acid pumps which have been fitted. Among some of the outstanding contracts completed during 1935 may be included a number for the explosives industries, where Ironac metal for nitric acid and for nitration plant is now so widely adopted.

Todd Brothers

Looking forward with confidence to a continuance of improved trading in 1936, Todd Bros. state that the past year has shown a maintained advance, and some reorganising has been essential to meet the demand for drums and kegs. Additional plant has been installed to cope with the probable demands of the near future. Users may therefore also look forward with confidence to their requirements being suitably dealt with as regards up-to-date design and manufacture with prompt execution.

George Kent, Ltd.

During 1935 George Kent, Ltd., received an increasing number of orders for their meters and automatic control gear. An important development from the industrial engineer's point of view has been the re-designing of the well-known KM recording flow meter. Modifications have recently been made which give a still greater reserve of power, increased accessibility, adaptability for any sort of service conditions,



Automatic Control Plant for Two Boilers (George Kent, Ltd.).

and other features which have arisen out of long experience with the KM meter. A number of complete panel schemes have been supplied to chemical works, laundries, paper mills, food factories and other industrial installations. Imperial Chemical Industries, Ltd., have ordered a considerable number of Kent meters and controllers for their various works, including 10 nitrogen-operated level regulators and

high pressure gas meters for their hydrogenation plant at Billingham. Ring balanced recorders have been supplied during the year in considerable numbers to the iron and steel industries for the measurement of blast furnace gas, furnace blast and other air or gas flow services. In order to cope with the manufacture of some of the more recently introduced products a new building is being erected.

The National Fire Protection Co., Ltd.

Starting with a new lease of life in January, 1935, a complete reconstruction of The National Fire Protection Co., Ltd., was then carried out. Their sales have now increased 600 per cent. since the beginning of the year, though this is largely due to the receipt of a very large Air Ministry contract to supply 6,400 extinguishers. So far as the chemical trade is concerned, they have supplied increasing quantities of extinguishers, automatic installations and fire tenders to Imperial Chemical Industries, Ltd., Coal and Allied Industries, Ltd., etc. A speciality has been made of automatic equipment for paint factories, and the company looks forward to more and more of these highly dangerous risks being brought into their fold in 1936. During the past year they have added a wide range of hose reels, standpipes, etc., to their list of products, as well as such allied items as surgical first aid-equipment.

Dexine, Ltd.

During 1935 Dexine, Ltd., have made steady progress. The installation of a testing laboratory and its approval by the Air Ministry Inspection Department has led to a substantial development of the sales of Dexonite super ebonite, and the company's products generally have found increasing favour from the chemical and allied industries. In order to facilitate more speedy handling of the rapidly growing volume of orders, an extensive addition to the works at Stratford has been found necessary, and building operations are proceeding. Additional plant of the most modern and efficient description is being installed, both in the existing and additional factory buildings. If the company's experience during the past twelve months can be regarded as a reliable index of its future prospects, the outlook for 1936 is distinctly encouraging.

J. Gray and Sons, Ltd.

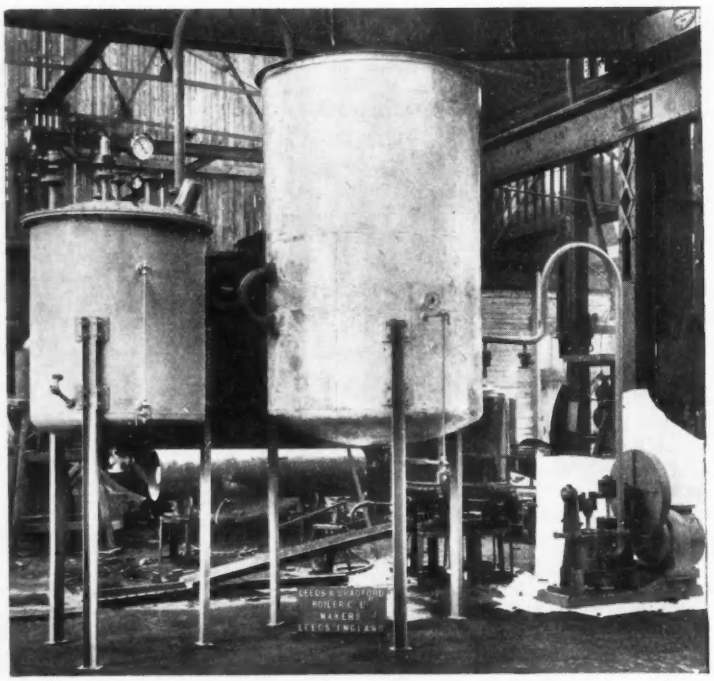
A very successful year has been completed by J. Gray and Sons, Ltd., who are enamelling engineers. They report that 1935 has seen the greatest advance since the company's inception. Home trade has been well maintained and in many cases improved upon considerably. The progressive policy of the company has resulted in the development of business with important firms in Portugal, Holland, Australia, New Zealand and China. Their policy for 1936 will follow that of previous years—maintenance of qualified service staff to deal with problems that arise in enamelling and the advancement of foreign and colonial trade, consistent with thorough deveopment of home trade. A vigorous selling campaign, in connection with the "Olympia" sifting machine, will be inaugurated during 1936. The company is convinced that the advantages of this machine are not fully realised by those manufacturers to whom efficient sifting of their materials is important.

L. Oertling, Ltd.

Among new instruments introduced by L. Oertling, Ltd., during 1935 have been their aperiodic and micro balances. For general analytical work an aperiodic, prismatic, reflecting balance has been supplied to numerous important industrial laboratories, where it is found greatly to expediate precision weighing. Handling of small weights and riders is eliminated, and the saving in time and fatigue where many weighings have to be made is enormous. A prismatic reflecting device has also been applied to one of the micro balances made by this company. In this balance a radial graticule is attached to the end of the pointer, and the magnified image of this is seen on an illuminated scale at the top of the balance case. This secures readings in 1/1,000ths of a milligram up to 0.1 milligram, plus or minus, without the use of riders or fractional weights.

Leeds and Bradford Boiler Co., Ltd.

The technical staff of the Leeds and Bradford Boiler Co., Ltd., has been extended by the inclusion of one who has exceptionally wide knowledge and practical experience in the chemical industry. This, coupled with the company's own long experience and excellent manufacturing facilities, will be found to be of very great benefit to their many friends in the trade.



Plant installed by the Leeds and Bradford Boiler Co., Ltd., for one of the largest firms in the country, for a distillation process which was not without its difficulties. Careful and intelligent design enabled a simple and easily operated plant to be supplied, and it is functioning with every satisfaction.

Evans, Adlard and Co., Ltd.

Filtering paper and filterings made by Evans, Adlard and Co., Ltd., are used in all parts of the world. Their output during 1935 is reported to have steadily increased, and the company looks forward to 1936 for a continuance of steady progress.

C. Myers

The improvement in the economical condition in this country has shown itself by an increased demand for first-class quality articles by the industrial laboratories, reports the firm of C. Myers. The increased demand for Royal Berlin laboratory porcelain ware and sintered glass filters has necessitated heavy stocks to be carried in London, so that supplies of all the popular sizes can be obtained through any

of the leading wholesale houses. Particularly gratifying to the importers has been the wonderful demand for the new Sartorius balances, which have been considerably reduced in price on account of the confidence shown in the English market.

Detel Products, Ltd.

Detel metal (zinc) undercoating supplied by Detel Products, Ltd., makers of protective coatings against acid, alkali and searrater, is reported to have evoked the most intense interest at works where corrosive conditions are encountered. This pure metallic zinc undercoating contains over 90 per cent. of metallic zinc in electrical contact with the underlying iron or steel surface to which it is applied, and thus affords true anodic protection and absolutely prevents any rust or corrosion from " creeping " under painted surfaces.

Athole G. Allen (Stockton), Ltd.

Reviewing the trading results for 1935, Athole G. Allen (Stockton), Ltd., state that they have every ground for satisfaction. There has been a steadily increasing demand for all the products manufacured by the company, for some of which they are the only makers in England against severe foreign competition. Their chief lines are barium carbonate, barium chloride, ferrous chloride, ferric chloride, ferric oxides, phosphoric acid, soda crystals and mono-, di- and trinitro-toluol. Operations were commenced in November, 1928, with ten employees, the works, then in a more or less derelict condition, extended over four acres. To-day over 100 employees are engaged and the area of the works is nearly 30 acres. The company's current trading year promises to be the most successful in its history, and in view of the many contracts already entered into by the company for the sales of its products over 1936, the coming year augurs well for its continued prosperity.

Guelph Cask, Veneer and Plywood Co., Ltd.

Considerable experiment carried out during 1935 has enabled the Guelph Cask, Veneer & Plywood Co., Ltd., to offer manufacturers cylindrical casks in a larger range of strengths and sizes than ever. For export or heavy work sturdy casks are obtainable. On the other hand, specially constructed kegs of lightweight can be supplied where it is necessary to restrict the tare of the container. In between these two types there are casks of a variety of strengths to meet the exact needs of each particular packing problem and the company has no hesitation in asserting that, in being able to supply this variety of sizes, strengths and types, its position is unique.

John W. Leitch and Co. Ltd.

The past twelve months have witnessed the consolidation of the position of John W. Leitch and Co., Ltd., with regard to the manufacture of aniline dyes for all trades and of Fast Bases (ice colours) for producing dyestuffs on the fibre, the excellent fastness to light and washing of this latter class being more widely recognised and appreciated. A very extensive range of fast pigment colours for paints, distempers, rubber and other industries is now being produced, and being pioneers of the manufacture of this class of colour in this country, the company is constantly on the look out for new developments.

John Thompson (Dudley), Ltd.

Activity in their homogeneous lead lining department is an outstanding feature of the report of John Thompson (Dudley), Ltd., all previous records having been surpassed. Stainless and heat-resisting steels of all well-known makes have also been used to a greater extent than formerly, and this also is true of metals of the Monel and nickel group. The boom in oil refining has given this company the opportunity of consolidating and advancing its position in this particular industry, and during the year it has had many repeat orders for tubular heat exchangers, some having as many as 1,100 tubes per heater tested to 650 lb. per sq. inch pressure. Interesting contracts included a tower evaporator for Herbert Green and Co., Ltd., refiners of petroleum products and lubricating oils at Killingsholme, Hull. This tower was 40 ft. long, weighed over 40 tons and was of electrically-welded construction throughout.

The Key Engineering Co., Ltd.

A most encouraging year has been the experience of The Key Engineering Co., Ltd. Key fibre conduit, which is used largely for the protection of underground cables, has been in great demand; this material is also useful for the transportation of acids. " Simplicity " steam traps, which have been improved considerably in construction, show a record of sales. Considerable progress has also been made with " Sy-vor " classifiers.

Metropolitan-Vickers Electrical Co., Ltd.

According to Metropolitan-Vickers Electrical Co., Ltd., the activity of the gold mining industry in South Africa was the cause of a number of orders for large electrical winding equipment, and the increased activity in the steel trade enabled orders to be placed for several electrically-driven rolling mill equipments. One of these is equipment for a large reversing rolling mill at the Briton Ferry Steel Co.'s Works, South Wales. Orders for metal-clad E.H.V. switchgear have arrived in fair quantity from sources both at home and abroad, and generally include control boards with mimic diagrams of the newest type.

F. Haworth

Acid resisting linings are becoming of particular interest to the cellulose branch of the trade owing to the fact that these linings are impervious to hot acids and also have the coefficiency of expansion and contraction of mild steel, reports F. Haworth, suppliers of acid-resisting cements and tiles. The linings in question can be installed with confidence in vessels subject to high temperatures and instant cooling without fear of fracturing the linings.

The Dowson and Mason Gas Plant Co., Ltd.

According to the Dowson and Mason Gas Plant Co., Ltd., prospects for the coming year are quite good. The only really new feature of their contracts has been the conversion of large furnaces to town's gas.

Copes' Regulators, Ltd.

Amongst contracts executed by Copes' Regulators, Ltd., during the past year, one of the most outstanding was for the supply of a high pressure regulator for a chemical works in the North of England. This boiler works at a pressure of 600 lb. per sq. in. It is anticipated that the use of high pressure steam in the chemical and allied works will increase during the coming year.

Hopkin and Williams, Ltd.

It is now a little more than a year since Hopkin and Williams, Ltd., in collaboration with the British Drug Houses, Ltd., compiled and adopted " ' AnalaR ' Standards for Laboratory Chemicals," as a specification for analytical reagents issued under the registered name " AnalaR." This venture has been attended with great success. Purchasers also enjoy the advantage of an improved type of packing. Screw top bottles are now employed with a moulded cap. The publication " Organic Reagents for Metals " appeared in a second enlarged edition early in the year. A number of new chemicals have been added to the company's products. These include phenyl-arsenic acid (for determination of tin), and phenyldi-iodoarsine. The latter liquid has the remarkably high R.I. of 1.845 and is of value in the examination of precious stones. An increase in the demand for Mandelic Acid for medicinal purposes has led to improvements in the manufacture of this acid and its sodium salt.

From Week to Week

THE REPORT on the sixth period of working of the British Chemical Standards Movement has just been published. It includes minutes of an important meeting held at York on November 30, at which the announcement was made of the formation of Bureau of Analysed Samples, Ltd., to take over the activities of the movement.

A REPRESENTATION HAS BEEN MADE to the Board of Trade under Section 10 (5) of the Finance Act, 1926, for the exemption of safrol from Key Industry Duty under Section 1 of the Safeguarding of Industries Act, 1921, as amended by the 1926 Act. Communications should be addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1, not later than January 18.

THE GOVERNMENT OF THE IRISH FREE STATE has imposed a duty of 33⅓ per cent. *ad valorem* on preparations of acid calcium phosphate in powder form imported into that country. The duty came into force on December 18, but the Order imposing it has a licensing provision which may, if the Minister for Industry and Commerce deems it advisable, admit the free importation of small quantities until such time as the factory which is being established in the Free State is in production.

THE REGISTRAR OF JOINT STOCK COMPANIES is also the Registrar of Business Names, but whereas the Companies' Registry has removed only twice in over ninety years, the Business Names Registry has removed to its fifth domicile in nine years. The Business Names Act was passed late in 1916, and the Registry was housed first in Russell Square, near the British Museum. From thence it was removed to Clements Inn, next (most convenient for searchers) to Somerset House, and then to Princes House, Kingsway. On December 19, it was removed to Chansitor House, Chancery Lane, W.C.2 (corner of Cursitor Street).

OWING to pressure of space we are compelled to hold over until next week our annual reviews of the Chemical Society, the Institute of Chemistry and the British Association of Chemists, and an article on the British synthetic fertiliser industry in 1935.

THE BRITISH SULPHATE OF AMMONIA FEDERATION has issued its report for the fertiliser year 1934-1935, showing an increase of 8.2 per cent. in the world consumption of nitrogen over the previous year.

IN A PAPER ON "Compressed Gas as a Fuel for Motor Transport," which he read in Nottingham on December 13, Mr. Robert Cook said that the system of gas propulsion employed by the various authorities in this country was in every case similar. Coal or coke oven gas (which it was usually considered advisable to debenzolise) was compressed to a pressure of 5,000 lb. per sq. in. in specially designed multi-stage compressors and stored at this pressure in fixed storage cylinders situated at the compressing station. The vehicles were fitted with a number of smaller storage cylinders which were charged from the fixed storage cylinders to a pressure of 3,000 lb. per sq. in. Flexible coupling pipes enabled charging to be carried out rapidly and an automatic valve in the charging line prevented any possibility of overcharging the vehicle cylinders. From the vehicle storage cylinders the gas passed *via* a stop valve, to a pressure-reducing valve, where the pressure was reduced in two stages down to approximately atmospheric. The gas then passed to the air-gas mixer where the requisite proportion of air was admitted. The mixture then passed through a flame arrester to the engine. The function of the flame arrester was to prevent the possibility of a flame travelling back from the engine to the gas system. When a vehicle was converted from petrol to gas propulsion the engine itself remained unaltered except that the compression ratio was usually increased by about one ratio so as to obtain the same power output as on petrol. In addition it was necessary to advance the ignition timing, whilst in certain cases it had been found advisable to modify the induction system.

AT A JOINT MEETING in the North British Hotel, Edinburgh, on December 12, of the Edinburgh and East of Scotland Sections of the Institute of Chemistry and Society of Chemical Industry, Mr. W. G. Hiscock, of the Scottish Dyeworks, Ltd., Grangemouth, read a paper on "Works Hygiene and Accident Prevention." In general, he said, the reactions which were carried out involved chemicals dangerous to the human system, their danger from toxicity or other reasons varying in degree only. In some reactions high temperatures were necessary, in others noxious gases were produced, while in others the reagents were corrosive. The task of safeguarding the worker was difficult. The policy of Imperial Chemical Industries was that those in charge of manufacturing processes were as responsible for carrying out their processes without accidents or ailments as for carrying them out with good yields, on time schedule and at economic cost. The choice of the worker was important, for most accidents could be traced to human failure. The intelligence of the worker was a valuable factor in chemical work.

THE GLEN SCOTIA DISTILLERY, Campbeltown, belonging to Bloch Brothers, is shortly to resume operations, when a season's distilling will be carried through. A few years ago 22 distilleries were in continual operation in Campbeltown, and not one is working to-day. The 50 per cent. reduction in the United States duty on imported whisky is said to have greatly improved the prospects for the Scottish export whisky trade.

BOOTS PURE DRUG CO., LTD., have just published a booklet entitled, "Acriflavine-Boots, Its Properties and Uses." Following a brief historical survey of the subject the booklet contains a description of the bactericidal and chemical properties of Acriflavine-Boots, neutral Acriflavine-Boots and Proflavine-Boots. Numerous indications for their use are given together with extracts from case reports taken from recent literature, and a selected bibliography.

THE LORDS COMMISSIONERS of the Treasury have appointed Dr. J. J. Fox, deputy Government chemist, as Government chemist, with effect from April 17 next, on the retirement of Sir Robert Robertson. Dr. Fox joined the Excise Service in 1896. Later he was put on the staff of the laboratory of Customs and Excise, which was eventually amalgamated with the Customs House staff and made into the Government Chemist's Department. He became deputy Government chemist in 1929.

A SOCIETY FOR THE STUDY OF ALCHEMY AND EARLY CHEMISTRY has been founded in London. The council includes scholars of international repute. It is proposed to hold regular meetings beginning early in 1936, at which papers will be read and discussed, and to publish a journal in which accounts of the papers will be given as well as special articles, written contributions by the members of the society, and reviews of books. Those wishing to become members are invited to write to the hon. secretary of the society at 8 Bream's Buildings, Fetter Lane, London, E.C.4.

STEELWORKS SLAG, which some years ago was regarded as a waste product, is now being used for the manufacture of foamed slag concrete at works which have been built alongside Richard Thomas and Co.'s Redbourne Hill steelworks, North Lincolnshire, from which the molten slag is taken. The newer process of dealing with the slag is proving so satisfactory that a further plant is to be installed adjoining other steelworks at Scunthorpe. It is claimed that foamed slag concrete blocks are lighter and cheaper than those made from ordinary concrete, and that their heat-insulating properties make them especially suitable for building purposes.

Chemical Industry Inventions

Applications for Patents

(December 5 to 10 inclusive.)

ESTIMATION OF FAT CONTENTS of milk, etc.—J. Golding. 33760.

AFFIXING A COATING to ferrous metal strip, etc., methods.—M. H. Heilbut. 34311.

COPPER COATING of articles.—M. H. Heilbut. 34312.

TERPINEOL FROM PINENE, production.—Hercules Powder Co. (United States, Jan. 9.) 34263.

TREATMENT OF ABIETYL COMPOUNDS, processes.—Hercules Powder Co. (United States, Feb. 13.) 34264.

ORGANIC MERCURY SILICON COMPOUNDS, manufacture.—I. G. Farbenindustrie. (Germany, Dec. 6, '34.) 33872.

CONDENSATION PRODUCTS, manufacture.—I. G. Farbenindustrie. (Germany, Dec. 6, '34.) 33873.

SUBSTANCES HAVING CAPILLARY ACTIVITY, manufacture.—I. G. Farbenindustrie. (Germany, Dec. 8, '34.) 34074.

WATER INSOLUBLE BASIC PRODUCTS in presence of a substratum, manufacture.—I. G. Farbenindustrie. (Germany, Dec. 14, '34.) 34379.

MONOAZO DYESTUFFS, manufacture.—Imperial Chemical Industries, Ltd., and A. H. Knight. 33732.

DISAZO DYESTUFFS, manufacture.—Imperial Chemical Industries, Ltd., A. H. Knight and M. Lapworth. 33792.

CELLULOSIC MATERIALS, treatment.—Imperial Chemical Industries, Ltd., 33897.

MINERAL OIL, producing.—L. Mellersh-Jackson (Standard Oil Co. of California). 33794.

ALCOHOL, distillation.—L. Mellersh-Jackson (Standard Oil Co. of California). 33795.

SPRAYING POWDERED SUBSTANCES, apparatus.—H. W. K. Jennings (Chemische Fabrik von J. E. Devrient A.-G.). 34256.

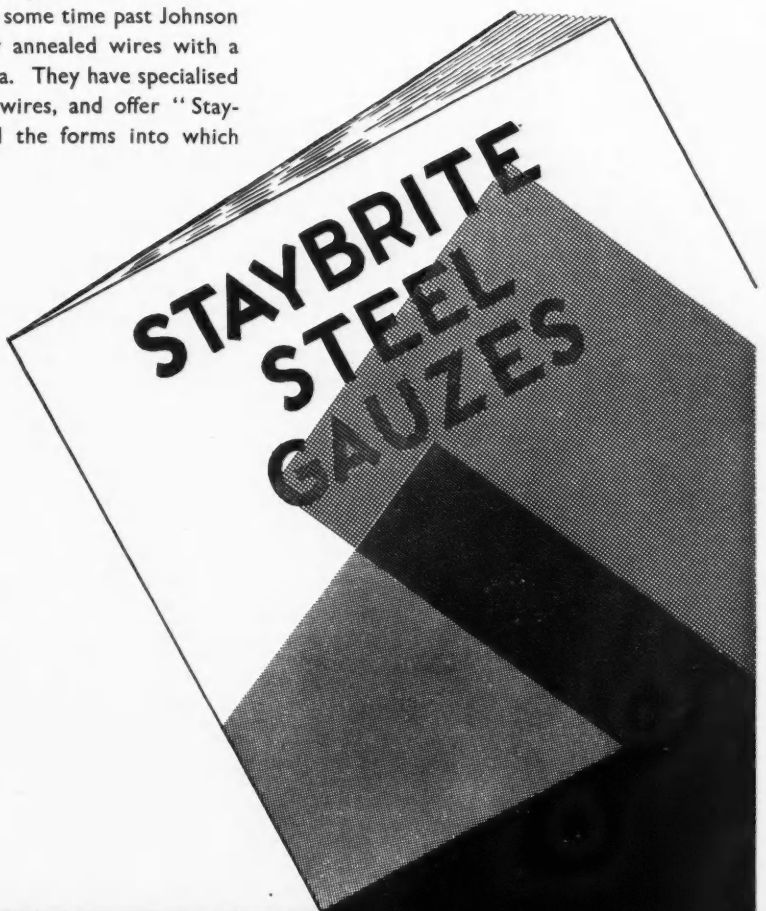
Metallurgical Section

Published the first Saturday in the month.

STAYBRITE STEEL GAUZE AND WIRE

The process of drawing fine "Staybrite" steel wires has been rapidly developed and for some time past Johnson Matthey have been supplying fully annealed wires with a mirror-like finish down to .0005" dia. They have specialised in gauzes woven from these fine wires, and offer "Staybrite" steel wire woven into all the forms into which other materials can be woven. Owing to the great strength of this wire, even when fully annealed, a lighter, and, therefore, more economical gauge can often be used.

"Staybrite" steel gauze and wire are invaluable in most industries because of the corrosion-resisting property of the metal.



Send to-day for this descriptive Publication No. 80.

JOHNSON MATTHEY & CO. LTD.
73/83, HATTON GARDEN, LONDON E.C.1.

ACID VALVES

Improved Non-Rotating Regulus Metal Angle Type Valve, with Solid Seating for Acids and other corrosive liquids.

APPLETON & HOWARD LTD.

Chemical Plant Manufacturers

ST. HELENS LANCASHIRE

Telegrams: "Bronze," St. Helens. *Telephone:* St. Helens 2544

Estd. 1776

TRADE MARK

Makers of

"SEA-CLIFF" Brand

PHOSPHOR BRONZE

MANGANESE BRONZE

ALUMINIUM BRONZE

IN TUBES, SHEETS, RODS AND WIRE

CHARLES CLIFFORD & SON, Ltd.

BIRMINGHAM

TODD'S

"AWLTOPLID" DRUM

The Steel Package with the full open top

Makers of ALL KINDS OF LIGHT STEEL

DRUMS & KEGS

TODD BROS.

Phone 167 WIDNES Grams "TODD"

CHEMICAL AND INDUSTRIAL ENGINEERING

Art and Principles of Chemistry	Armstrong	15	0
Bituminous Substances	Spielmann	15	0
Cellulose Acetate	Lipscomb	21	0
Chemistry, Manufacture and Application of Artificial Fertilisers. Vol. I	Ogilvie	45	0
Chemistry of Chemotherapy	Dyson	32	6
Chemistry of Drugs. 2nd Ed.	Evers	55	0
Condensed Outline of Modern Physical Chemistry	Constable	10	6
Drying by Means of Air and Steam	Hausbrand	6	0
Dye Chemistry	Georgievics	15	0
Evaporating, Condensing and Cooling Apparatus	Hausbrand and Heastie	25	0
Fats: Natural and Synthetic	Myddleton	10	6
Filtration and Filters	Pickard	45	0
Foundations of Colloid Chemistry	Hatschek	7	6
Industrial Catalysis	Green	50	0
Industrial Uses of Bauxite	Knibbs	21	0
Limestone and its Products	Searle (*in preparation*)		
Making of a Chemical	Lewis and King	12	6
Manufacture of Sulphate of Ammonia and Crude Ammonia	Calvert	3	6
Paper Mill Chemist	Stevens	10	6
Recent Progress in Rubber Chemistry and Technology	Schidrowitz	3	6
Recovery and Use of Industrial Wastes	Kershaw	25	0
Specific Heats of Gases	Partington	30	0
Synthesis of Benzene Derivatives	Bate	9	6
Synthesis of Nitrogen Ring Compounds	Hollins	55	0
Synthetic Rubber	Schotz	21	0
Utilization of Wood Waste	Hubbard	5	0

CHEMICAL ENGINEERING MONOGRAPHS

Agitating, Stirring and Kneading Machinery	Seymour	2	6
Autoclaves and High Pressure Work	Goodwin	2	6
Centrifugal Dryers and Separators	Alliott	2	6
Design and Arrangement of Chemical Plant	Weyman	2	6
Distillation in Practice	Elliott	2	6
Dust Hazard in Industry	E. Gibbs	2	6
Mechanical Draught	Lister	2	6
Mechanical Mixing Machinery	Carpenter	2	6
Organization of Production	Curtis	2	6
Sulphuric Acid Concentration. 2 Vols.	Parrish, *each*	2	6
Sulphuric Acid Reaction Chambers	Parrish	2	6
Transport and Handling of Mineral Acids	Hirsch	2	6

Full details of any book sent on request.

ERNEST BENN LIMITED, Bouverie House, Fleet Street, London, E.C.4

Metallurgical Section

July 6, 1935

Refractories for Metallurgical Work

EXHIBITS of metallurgical interest were shown at the National Physical Laboratory on the occasion of the annual inspection by visitors on June 25. These exhibits included apparatus made of special refractory materals for use in researches at high temperature, new apparatus for the study of the creep of metals at high temperatures in vacuo, a new potentiometer for taking heating and cooling curves, apparatus for raising and lowering the temperature of a furnace at uniform rate, and a large thermostat for controlling the temperature of a number of separate furnaces. The study of special refractory materials suitable for use at elevated temperatures and for the melting of metals and alloys of high purity has received particular attention at the Laboratory during the last few years. A paper embodying many of the more recent results of this work was published in the " Transactions of the Ceramic Society."

Refractories to meet the special requirements of metallurgical researches are not normally available from commercial sources. Pure alumina refractories have been found to be unsuited for use in contact with molten alloys of iron and carbon. Crucibles of pure thoria, and alumina crucibles lined with thoria, are now being prepared for the work on the iron-carbon system. Efforts have been made to obtain a completely impervious refractory of the recrystallised alumina type, as well as one which will mature at a somewhat lower firing temperature, in order that some other means of firing these refractories may be substituted for the present graphite-ring electric resistance furnace. Various alternative means of firing these highly refractory bodies in a non-reducing atmosphere are being considered, and certain preliminary experiments have been conducted, including the use of a bath of molten aluminium heated in the high frequency induction furnace. The possibilities offered by thoria-alumina mixtures are receiving special attention, particularly with a view to the production of impervious refractory bodies.

Improved Methods of Analysis

QUALITATIVE methods of microchemical analysis have continued to be of value at the Laboratory in the task of identifying corrosion products and deposits which appear in small quantities. The crystal method has been mainly used and photographs of typical preparations have been taken for the purpose of reference. Gravimetric methods were employed for the quantitative analysis of a number of coppers and bronzes where only a small amount of material was available. In most cases 8 or 9 milligrams of material was sufficient for a complete analysis. Spectrographic analysis has also continued to prove valuable in the examination of metal specimens occurring in the work of the Laboratory. Frequently the smallness of the samples submitted makes it essential to employ the method in which an oscillating spark is formed between two electrodes. A considerable number of quantitative analyses of powders have been made by examination of the spectra obtained from pellets heated in a copper arc. Difficulties in ensuring reproducible results have now led to trials of a high-tension arc between a metal electrode and a dish in which the powder is mixed with a fusion mixture.

New Work on Aluminium Alloys

THE constitution at 500° C. of a series of alluminium alloys containing 4 per cent. of copper has now been determined at the National Physical Laboratory as part of the programme of Government research, and their age-hardening at room and higher temperatures has been studied. An investigation has also been in progress on the effect of up to 2 per cent. silicon on the fatigue, impact and elastic properties of commonly used aluminium casting alloys. The production of test bars, of the uniformity desired for the investigation has proved troublesome, and electric melting with the latest methods for removing dissolved gas from the molten alloy before casting have been adopted. The contamination of metal in melting operations, by hydrogen derived from moisture in the crucible, has been further examined. Castings poured at intervals from metal maintained in the molten state in plumbago-clay crucibles heated in an electric furnace are found to become progressively unsound, even when the crucible has been pre-heated for a considerable period. This evolution of gas from the material of the crucible, or from stirrers of similar composition, has so far masked the effect of any contamination which may arise, when gas or oil firing is employed, from diffusion of furnace gases through the walls of the crucible.

In the study of the factors controlling the grain size of cast aluminium, it has been confirmed that the maximum temperature to which the molten metal is heated exerts a controlling effect on the grain size, particularly of sand-cast metal, even when the casting temperature is kept low. The alloy with 7 per cent. of copper, when heated to 800° C. before casting at 700° C., gives a considerably coarser structure than metal heated to 700° C. and immediately cast; the 12 per cent. alloy appears to be still more sensitive. Occasionally this coarsening of structure is reduced by maintaining the overheated metal at 700° C. for some hours. On remelting after solidification, the structure which existed before overheating is restored, and the effect appears to be independent of the soundness of the metal.

A Five-Year Programme of Research

THE inauguration of a five-year plan of research was announced by the British Non-Ferrous Metals Research Association, on the occasion of their fifteenth annual general meeting, held in Birmingham, on June 18. Appealing for further financial assistance in order to enable the Association to take advantage of a Government grant for research, Mr. Thomas Bolton, chairman of the Association, said it was not a part of the function of a research association to destroy or discourage healthy competition. On the other hand, it was its function to provide more and more material in the use of which its members might compete. There might be full co-operation without eliminating that healthy competition that was the secret of success. Before entering into negotiations with the Government in connection with grants for research the council had decided to investigate fully the subjects on which research was most needed. About 140 suggestions for research were sent in, and the specially appointed committee was able to suggest a programme for five years' work. This programme was based on a definite scheme, which could be easily expanded as funds might become available. In any one of the next five years the industry had to provide £14,000 before it could receive a grant. In return for that the Government gave a block grant of £8,000. There was a further sliding scale grant bringing the Government grant up to maximum of £12,000, if £19,000 was provided in industrial subscriptions. Mr. Bolton said this was the first year of the Association's five-year plan and they would be gratified if they could set an example in five-year plans by doing more than they set out to do.

Corrosion Centres on Steel

THE number of centres at which corrosion will commence on mild steel when immersed in different solutions has been a subject of recent investigation at the Chemical Research Laboratory, Teddington. It is commonly believed that the number of these centres is determined by the nature of the air-formed oxide film and by the penetrating power of the anions in solution, of which the chloride ion is supposed to be specially active, and that an increase of the partial pressure of oxygen reduces the number of centres. Evidence for these views has been obtained mainly by placing drops of solution on the metal and by experiments with partial immersion, but they do not appear to hold for totally immersed metal. Oxide films as formed at atmospheric temperature on mild steel do not show interference colours characteristic which are of continuous films, even when formed by exposing the metal to the action of oxygen at a pressure of 50 atmospheres for 25 days, or to the action of atmospheric air for a period of $2\frac{1}{2}$ years. Under these conditions the weights of the respective films show that they are sufficiently thick, and the reason that they do not show colours seems to be that their texture is granular and not continous. In conformity with this, experiments at the Chemical Research Laboratory have shown that the starting points for corrosion on finely turned steel in a solution of sodium chloride or potassium chloride (N/10,000) are possibly several thousands per sq. cm. These points are not greatly reduced in number if distilled water or N/10,000 sodium sulphate, bicarbonate or nitrate, are substituted for sodium chloride.

Protective Value of Platings

THERE has not always been unanimous agreement as to what constitutes the most satisfactory electro-deposited coating for ensuring resistance to corrosion. From the results of a series of exposure tests for plated steel specimens, carried out under the control of a joint committee formed by the American Electroplaters' Society, the American Society for Testing Materials, and the United States Bureau of Standards, it appears that the protective value of nickel coatings depends almost entirely on their thickness. At least 0.0005 inch is required for good protection under mild (indoor) conditions, and at least 0.001 inch for more severe conditions. The exact conditions of nickel deposition and of the cleaning and pickling have no marked effects on the protective value, provided an adherent uniform coating is obtained. The presence of a layer of copper reduces the protective value of thin nickel deposits under all conditions, and of thick deposits under severe conditions. If chromium is also present, the copper has little harmful effect in thick deposits. The use of zinc under nickel makes the protective value less than that of either metal alone; in addition, it tends to produce white stains and blisters. A very thin deposit of chromium, such as 0.0001 inch, sometimes reduces the protective value, especially of pure nickel deposits. Chromium coatings about 0.00002 to 0.00003 inch add very little to the protective value, but maintain their bright appearance owing to their resistance to tarnish. Relatively thick chromium coatings from 0.00005 to 0.0001 inch improve the protection against corrosion, especially in an industrial atmosphere. These findings refer to a steel base which was plated under accurately controlled conditions at the Bureau of Standards, and then exposed for a period of two years in various types of atmosphere.

The Steel Cartel Negotiations

THE discussions between the British Iron and Steel Federation and the Continental Steel Cartel are still at a very general stage. It seems that arrangements to control and to distribute British imports, and to regulate British exports of steel goods, two closely-related problems, will not be finalised for some time, but certain agreements in principle have been reached. At the recent Luxemburg meeting it was decided to limit continental steel exports to Great Britain to 670,000 tons per annum, during the first year of a five-year period. This quota will be applied at the end of the present temporary agreement, based on 643,000 tons per annum, and due to expire on August 8. During the four following years continental steel exports to Great Britain will be fixed at 525,000 tons per annum. The global export tonnage allotted to the British industry, in exchange for the concession of privileges on the British market to continental producers, has been fixed on the basis of the 1934 exports. Since British exports last year were far below the normal level, the British representatives pressed for preferential treatment under a sliding scale arrangement. It was suggested that two-thirds of any increase of total exports over the 1934 figures should be given to the British industry, the remaining third being divided among Cartel members. Participants will be allowed to ship material to Britain, under special licence, and possibly at a special reduced rate of duty; non-Cartel members would encounter the usual tariff barriers.

Improving Metal Surfaces by Electrical Oxidation

Advantages of the "Eloxal" Process

THE oxidation of metal surfaces is a well-proved means of protecting these surfaces from atmospheric and other corroding influences. In recent times this method of protection has been especially developed for aluminium, magnesium, and their alloys. The advantage offered by such oxide-protecting films is that they are perfectly adhesive and form neither cracks nor scales.

The forming of an adhesive oxide coating of suitable physical properties, however, is not quite simple, and at different times a large number of chemical processes have been proposed, some of which do not produce pure oxides but more or less similar compounds. Some of the later processes produce an oxidised surface characterised by great hardness; both in the United States and in Germany, this fact has led to light metal pistons being given an artificial oxidation on the surface to increase their resistance to wear. The best known of these later electrically-oxidising processes is the so-called "Eloxal" process.

In Ger. Pat. 453,886 it is proposed to form a protective coating of good adhesive properties, considerable hardness and resistance to corrosive attack with phenol; in Ger. Pat. 530,018 the oxidised surface first obtained is further protected by a sulphide coating produced by the action of carbon disulphide. Ger. Pat. 550,285 describes an oxidation process which is produced by ammonia vapour. In French Pat. 623,335 a porous surface is obtained which is made impervious by immersion in lubricating oil, heating and pressing. Ger. Pat. 366,661 provides for the protection of magnesium surfaces by gum, or substances of a fatty character, while Ger. Pat. 412,020 proposes the protection of "elektron" metal surfaces by first oxidising the same with an alkali solution and then impregnating this surface with oil.

Action of Nascent Oxygen

Of the processes mentioned, the "Eloxal" process of electrical oxidation appears to be the most practical and effective; this process was discussed at some length in "Zeit V.D.," I, 1934, *78*, 1449. Actually, the oxidation of the metal surfaces to be protected is effected by the electrolysis of a dilute acid solution in which the nascent oxygen released acts on the metal surface. The acids used may be chromic, oxalic, or sulphuric acid, and the electric current can be either direct or alternating. Besides the acids, additions such as a little nitric acid, glycerine, calcium sulphate and others may be made to the bath. The oxidation may be carried out with the material immersed in the bath or by spraying the electrolyte over the surfaces of the material. In treating wire or band metal, the material can be conveyed through the bath by rolls. Pure aluminium and alloys of the same, free of copper and low in silicon, such as Anticordal, Aldrey, and Hydronalium, are the easiest to treat.

The properties of the oxidised surfaces can be modified to some extent, according to the purpose for which the treated material is intended, namely, in hardness, resistance to wear, colour, etc. The usual thickness of the oxidised skin is from 0.02 to 9.94 mm. The current consumption varies according to the properties of the metal, the composition of the electrolyte, the thickness of the oxidised layer but ranges from 3.5 to 12 kW-hours. The cost of applying the process to surfaces for decorative purposes amounts to 1.5 to 2.5 M. per square metre of surface.

A Hard Oxide Skin

As might be expected, the oxide skin adhers very strongly to the ground metal below, from which it can be removed only by severe wear. The hardness of the surface lies between that of quartz and corundum. The resistance to both high temperatures and abrasion is high; the oxidised surface is somewhat porous and, if it is intended to be used in contact with corrosive fluids or vapours which would attack the ground metal, the surface is treated with wax, fats, oils, lacquers, or by some substance which will make it impervious, the particular substance selected being determined by the use to be made of the metal. Porosity can also be overcome by treating the oxidised surfaces with a live steam jet, a boiling solution of bichromate, or acetates of the heavy metals which are easy to hydrolyse. After appropriate treatment in this way the oxidised surface is resistant to the action of all kinds of fresh water, sea water, salt solutions and nearly all organic aids and their salt solutions, or liquids like alcohols and glycerine, as well as photographic developers, hydrogen superoxide and gases, such as flue gas, hydrogen sulphide and many others. The oxidised surface can be given any desired colour, either with organic or inorganic pigments.

The hardness and resistance to wear of the "Eloxalised" surfaces gives the treated material a wide field of employment in the machine construction, automobile and aircraft manufacture, and in ship-building. The high resistance of the treated surfaces to corrosive influences makes it also of great service in the construction of apparatus of different kinds for the food and chemical industries. The good insulation properties of the oxidised metal surfaces makes its employment in the electro-technical industry considerable; it is especially useful as insulation material where high temperatures are involved at which many organic insulations would be destroyed. Aluminium objects which require no further form changes can be given hard and comparatively thick coatings of oxide which are very resistant to wear, but where high temperatures are involved a thick coating is not desirable because cracks in the surface may develop, reducing both the insulation value and th eresistance to corroding influences.

A Bakelite-Impregnated Oxide

For objects which require considerable bending or distortion after oxidation, the surface should be given a quite thin coat of oxide which may be impregnated with a flexible substance of the bakelite type which will make it very resistant to corroding liquids or gases. The temperature stability depends on the impregnating substance used.

An important field for the employment of aluminium oxidised by the "Eloxal" process has been opened by the development in the use of heating equipment and heat exchange constructions now that it has become known that the heat radiation capacity of an aluminium surface can be increased by about six times by giving it a comparatively thick "Eloxalised" surface. Through a special treatment of aluminium surfaces and a slight oxidation by the "Eloxal" process the heat reflective capacity is so far increased as to about correspond with that of a silver mirror. Coloured "Eloxalised" surfaces are finding many uses for decorative purposes in industry and elsewhere.

World Tin Consumption

Notable Increase Reported during April

ACCORDING to the June issue of the "Bulletin of the International Tin Research and Development Council," the consumption of tin in manufacture during the first four months of this year totalled 46,400 tons, against 43,800 tons and 35,900 tons respectively in the corresponding months of 1934 and 1933. This year's consumption shows an increase of 6 per cent. over last year, and the figures show that the increase is very largely due to the expansion of the tin consuming industries in the United States.

During the year ended April, 1935, the world used 132,600 tons of tin against 138,900 tons in the previous year. The fact that these figures indicate a decrease of 4½ per cent. when world consumption is increasing, is explained by the exceptionally heavy imports of tin into the United States during 1933.

The world's apparent consumption of tin in April, 1935, amounted to 11,343 tons, compared with 10,304 tons in April, 1934. The apparent consumption in the United States in April, 1935, was 4,893 tons, against 4,049 tons in April, 1934; in the United Kingdom 2,161 tons, against 1,111 tons, and in other countries 4,289 tons, against 5,144 tons. In April, 1935, the world production of tinplate amounted to 331,000 tons, compared with 285,000 tons in April last year.

External Heat Losses of Blast Furnaces

Further Investigations

FURTHER investigations of the external heat loss of blast furnaces were given in a paper which Mr. D. F. Marshall, B.Sc., Tech.,Ph.D., read before the Iron and Steel Institute in May. This paper provided a record of an experimental determination of the external heat loss from four blast furnaces, selected to cover a wide range of rate of production, type of product and general practice. The influence on the heat loss of various factors, such as the rate of drive, the life of lining, cooling winds, exposed sites, the use of bosh tuyeres and the water cooling of shafts, was investigated and an attempt made to measure their effect on furnace operation, in terms of fuel consumed. Results indicated that the external heat loss was largely a function of the superficial area of the furnace and was considerably lower than the estimates previously given. The relationships existing between the heat losses from the furnaces examined, however, did not appear to be materially affected by changes in operation from furnace to furnace, or on one furnace. In all cases the cooling water used accounted for more than 83 per cent. of the total heat loss and it seems probable that a study of this loss might result in improvements in furnace operation. The heat losses by radiation and convection from the shaft, and by conduction through the ground, were relatively small.

Heat Loss in Water-Cooled Zone

These investigations of external heat loss have confirmed the conclusion that this loss has previously been overestimated and occurs mainly in the cooling water. In all cases the heat carried away in the cooling water amounted to over 82 per cent. of the total loss. The tests have indicated that the total external heat loss is not markedly influenced by differences in furnace operation, except where such changes create a necessity for additional water cooling, such as the use of bosh tuyeres or cigar coolers on the shaft.

It has been found that the heat loss per unit surface area of the water-cooled zones (bosh, spectacle belt, and hearth) is very similar on all the furnaces examined, but it does show a tendency to decrease slightly on the larger furnaces. It follows, therefore, that the total surface area of the water-cooled regions on a furnace is an important factor governing the total external heat loss from that furnace. One furnace examined incurred additional water-cooling losses in bosh tuyeres and cigar coolers. The results at this plant fell closely in line with those obtained at others when due allowance was made for the additional heat loss involved by the extra cooling. There is a very considerable variation in the amounts of cooling water used from plant to plant, even where similar types of cooling are employed. It is possible, therefore, that considerable economies of both heat and water might be effected by making a systematic examination of the distribution of the heat loss in the cooling water at each furnace.

Cooling Effect of Strong Winds

It has also been found that the heat loss from the shaft of each furnace constitutes a relatively small proportion of the total loss. The cooling effect of strong winds and the influence of exposed furnace sites are therefore correspondingly small factors governing the total heat loss. The experimental results suggest that the value of shaft insulation lies not in the actual reduction of the shaft heat losses, but in the possibility of prolonging the life of the furnace lining. Although the heat loss per unit of shaft area tends to increase as the lining ages, there is some evidence that the rate of drive of a furnace plays a more important part in governing the loss of heat from the shaft.

At three of the furnaces, operating on similar types of lean ores, the maximum temperatures recorded on the shaft were approximately equidistant from the nearest tuyeres, and in one of the furnaces, where a collapse of the lining occurred subsequently, this took place at the zone of maximum temperature. It is interesting to note that on the furnace using bosh tuyeres the maximum shaft temperatures were much higher up the shaft than on any other furnace, but were still at approximately the same distance from the nearest tuyere, that it, the bosh tuyeres. On one furnace, using richer ores, this distance became much less. These observations suggest that water cooling of the shaft which is now coming into use could profitably be restricted to that part of the shaft around the maximum shell temperature zone.

The plants at which the experimental work was carried out were those of Newton Chambers and Co., Ltd., Thorncliffe, Sheffield; The Park Gate Iron and Steel Co., Ltd., Rotherham; The Workington Iron and Steel Co., Workington; and the Frodingham Iron and Steel Co., Ltd., Scunthorpe.

Porosity of Tin Coatings on Steel

Methods of Determination

THE relative freedom from pores has come to be recognised as one of the chief factors determining the quality of tin coatings for many industrial purposes. As the result of an investigation of porosity, carried out at the Research Department, Woolwich, for the British Non-Ferrous Metals Research Association, two methods of determination were outlined, *viz.* (1) the ferricyanide-paper test, in an improved form, and (2) the hot-water test, a new method which consists in keeping the degreased tinplate in hot distilled water for some hours, when adherent rustspots form at the pore sites, rendering them clearly visible. These two procedures gave closely similar values for the porosity of coating of tinplate as manufactured, and in order that they might be used to the best advantage the International Tin Research and Development Council issue a description of them with special reference to practical technique (Technical Publication, Series A, No. 7. "The Determination of the Porosity of Tin Coatings on Steel." By D. J. Macnaughton, S. G. Clarke and J. C. Prytherch).

In the hot-water test the degreased specimen is immersed in distilled water which has been heated almost to boiling; sheet specimens should be placed so as to stand in a more or less upright position. The water is maintained at not less than 95° C for about six hours, when the specimen is removed. The period of heating may be reduced to three hours if the specimen is left overnight in the water, which is allowed to cool down to room temperature. During the heating reddish-brown spots having black nuclei form on the previously bright surface. These spots are very adherent and do not become detached during handling. A record of the degree of porosity may be made by counting the number of spots, a process which is facilitated in the case of sheet specimens by superimposing a sheet of glass ruled in 1 cm. squares.

This method requires water of high purity, as the presence of even small amounts of a wide variety of salts, including alkali chlorides, prevents, either partially or completely, the development of the rust spots. The water may be prepared by distilling tap water, a single distillation employing a condenser of block tin or heavily tinned copper being usually sufficient, and it should be kept free from contamination. The water should be neutral or very slightly acid. A simple test for determining whether it is satisfactory is to take a 10 c.c. sample and add five drops of methyl-red indicator (0.02 per cent. in 1 : 1 alcohol-water mixture), when the colour should be pale pink. If the colour is even faintly yellow—for instance, as a result of storing the water in a

vessel of ordinary soft glass—the water is alkaline and unsuitable, but it may be treated so as to render it satisfactory for use by adding very dilute hydrochloric acid sufficient to give a pink reaction with the methyl-red indicator (say, 1 c.c. of a solution of 1 part of concentrated hydrochloric acid in 1,000 parts of water, *i.e.*, approximately 0.01 *N*-acid) to 1 litre of the water.

The hot water method is suitable either as a routine test or a research test for tin-coated steel in all forms. It may be accepted as reliable since investigation has shown that (1) there is no attack of the tin coating, such as would cause its perforation and therefore lead to a fictitiously high figure for porosity, (2) the conditions strongly favour attack of the exposed steel with the formation of a corrosion product which does not obstruct further attack, so that rust spots will tend to form at very small pores, and (3) rust spots can occur only at definite breaks in the coating, since the only other possible source of rust is the iron-tin compound $FeSn_2$, which was found to remain unaffected in the test.

The Ferricyanide-Paper Test

In the ferricyanide-paper test the sheet of tinplate to be tested is thoroughly degreased. A piece of paper of about the same size as the specimen is spread upon a sheet of glass and made uniformly damp by brushing it with a freshly prepared solution containing potassium ferricyanide (1 gm.) and sodium chloride (0.5 gm.) in 100 c.c. of distilled water. The paper should not be made so wet that liquid will drip from it when it is allowed to hang vertically, or the blue spots when formed will be diffused and lack definition. The damp paper is placed on the specimen and brushed into close contact with it by means of a brush rendered slightly damp with the reagent. After 10 to 15 minutes, depending on the temperature and humidity of the air in the room, the paper will tend to become dry and to separate from the specimen. The paper should then be brushed with a brush slightly damped with distilled water, and this treatment is repeated at intervals during the test.

Counting the Corrosion Centres

After one hour the paper is removed, well washed to remove soluble salts, and suspended in the air until dry. The test paper then provides a permanent record of the porosity. To facilitate counting the pores, the paper may be ruled in 1 cm. squares, or alternatively, a ruled glass sheet may be superimposed on the paper. A low power lens such as a reading glass should be employed in counting in order to ensure that the smallest blue spots are detected.

Since transference of the blue corrosion product from the pores to the paper depends on securing satisfactory contact between the paper and the tinplate sheet, the paper used should have a smooth surface and be of fine texture. It should further be sufficiently thin that it may adapt itself readily to any undulations of the tin surface, and strong enough when damp to resist rupture during the brushing treatment; "smooth, 22 lb." paper is suitable.

The chief field of usefulness for the ferricyanide method would appear to be testing flat tinplate sheet as manufactured and tinned surfaces which are sufficiently regular to allow adequate contact with the paper. The original test-experiments showed that the ferricyanide method is unsuitable for determining the porosity of tinplate which has been subjected to cold work such as bending, stretching, indentation or buffing prior to the test, since the coating becomes attacked in the stressed areas resulting in an abnormally high value for porosity.

A British School for Foundry Practice

New Scheme Receives Support from Research Associations

MEETINGS have recently taken place which have resulted in the formation by the founding industry of a provision governing body for an entirely new type of specialised school, the British Foundry School. If sufficient students present themselves, it will be opened in September of this year. The school, according to the prospectus, is intended for those men engaged in the founding industry (including grey iron for both light and heavy work, white and chilled iron, malleable cast iron, steel and the non-ferrous metals), who have already had some practical experience and who wish to qualify for, or who have already shown their capacity in, managerial and supervising posts. It will provide a full-time day course of one year's duration and successful students will receive a diploma.

Board of Education Grant

Out of a net running cost (total expenditure less receipts from students' fees, fixed at £30 per annum) of £2,000 per annum, the Board of Education has undertaken to provide £1,500 in the form of grant, provided the remaining £500 is forthcoming from the industry. Of this latter sum, nearly one-half has been promised by a group of institutions representing the industry, which are supporting the school and which have nominated representatives to the governing body. The industry is now invited to contribute the remainder, about £300 per annum. It is felt that the industry will welcome the opportunity of showing its sense of the need for the school by contributing this comparatively small sum. It is well-known that vacancies for foundry managers and foremen who can combine metallurgical and technical knowledge with managerial experience are difficult to fill.

Schools for the higher training of foundrymen have been established in France and Germany and the remarkable advances which are now being made in founding necessitated provision of the kind indicated being made for this country. The bodies who are supporting the school include the British Cast Iron Research Association, the British Iron and Steel Federation (Iron and Steel Industrial Research Council), the British Non-Ferrous Metals Research Association, the Institute of British Foundrymen, the Institute of Metals, the Iron and Steel Institute, and others.

Through the public-spirited action of the Birmingham Education Committee, the school will be housed in the Metallurgical Department of the Central Technical College. Mr. R. G. Hosking has been appointed chairman of the provisional governing body, Alderman W. Byng Kenrick, vice-chairman, and Mr. J. G. Pearce, hon. adviser and hon. treasurer, to whom requests for information may be sent, at 21 St. Paul's Square, Birmingham.

No attempt will be made to give students practical experience in founding or patternmaking. The curriculum will include the development and structure of the foundry industry and its various divsions, both at home and abroad, and the organisation and planning of foundries, including costing. The raw materials, equipment and processes of the industry will be dealt with fully, along with the metallurgy of cast iron, cast steel and the cast non-ferrous metals. Laboratory instruction will be provided in mechanical testing, microscopical examination and chemical analysis, the testing of sands and refractories and in foundry technique.

German Lithopone Trade

THE German lithopone industry, which recorded steady gains since 1932, has been showing weakening tendencies during recent months and the prospects of an improvement in trade conditions are not bright. Owing chiefly to the effects of British currency devaluation and heavy losses in the important British market, as well as the Netherlands and China, German lithopone exports, which had dropped in 1932 to only 11,890 tons (from 18,102 in 1931), recovered to 13,053 tons in 1933 and 14,170 tons in 1934. However, this year exports declined to 3,400 tons in the first quarter, compared with 3,738 in the same period last year. The principal purchasers of lithopone for the first quarter of 1935 were Great Britain (804 metric tons), China (469 tons), and Denmark (190 tons).

Some Recent Metallurgical Patents

Aluminium Alloys

ALUMINIUM magnesium alloys are improved by maintaining the alloy in a molten condition in an inert atmosphere for at least 24 hours; for example, the molten alloy may stand in an electric furnace in an atmosphere of carbon dioxide for 2 to 3 days. The alloys may contain 2 to 15 per cent. of magnesium, with or without other elements such as manganese, cobalt, chromium, antimony, cadmium, or arsenic. (See Specification No. 425,096, of Vereinigte Leicht-Metall-Werke Ges.)

Concentrating Gold and Silver

TO recover gold or silver from ores or metallurgical products such as slimes or residues the soluble gold or silver is dissolved in cyanide, a large excess of carbonaceous precipitant such as powdered charcoal, ground coke, or graphite is added, and the pulp subjected to flotation concentration to obtain a float containing the gold or silver and the precipitant. If the soluble gold or silver is associated with pyritic minerals containing precious metals the pyritic minerals are removed by a preliminary flotation before adding the cyanide to dissolve the soluble gold, etc. (See Specification No. 424,997, of V. T. Edquist.)

Cast Iron

IN the manufacture of cast iron titanium or an alloy containing titanium is added to the charge or to the molten iron and the titanium in the melt subsequently oxidised either by passing an oxidising gas such as air or carbon dioxide through the melt or by adding a solid oxidising agent, such as a carbonate or an oxide, to the melt. After the oxidation of the titanium hydrogen may be blown through the melt so as to coarsen the graphite in the iron. Instead of hydrogen, hydrogen-containing compounds such as steam or hydrocarbons may be used. If too much hydrogen is dissolved in the molten iron, the excess of hydrogen may be removed by blowing nitrogen, air, or carbon dioxide through the molten metal. (See Specification No. 425,227, of British Cast Iron Research Association, A. L. Norbury and E. Morgan.)

Coating with Metals

IRON or steel articles are protected against corrosion by coating first with a metal such as zinc and then with an aluminium bronze containing a high percentage, *e.g.*, 80 to 92 per cent. of copper, the composition of the bronze being such that its mechanical characteristics are approximately the same as those of the iron or steel. The coatings are preferably applied by dipping. For coating carbon steel such as is commonly used in the manufacture of rolled steel, piping, etc., an alloy consisting of 90 per cent. copper and 10 per cent. aluminium may be used; for coating soft Thomas steel the alloy may consist of 88.9 per cent. copper, 5 per cent. aluminium, 5 per cent. nickel, 1 per cent. manganese, and 0.1 per cent. phosphorus; and for coating hard Martin steel the alloy may consist of 82.9 per cent. copper, 10 per cent. aluminium, 5 per cent. nickel, 2 per cent. manganese, and 0.1 per cent. phosphorus. (See Specification No. 425,717, of Soc. Vallourec.)

Recovering Precious Metals

ORES, metallurgical by-products, and residues such as slimes, sludges, and anode mud containing selenium and precious metals are roasted and leached with sulphuric acid to remove copper, and the residue subjected to controlled oxidation in the presence of an alkali compound to convert selenium present to alkali selenite, which is then dissolved out leaving the precious metals as an insoluble residue. In the treatment of anode mud produced in the electrolytic refining of copper, the precious metal residue containing 88 per cent. of precious metals is washed, treated with hot dilute sulphuric acid to remove any remaining copper, selenium, and tellurium, and melted down with a small amount of sodium hydroxide-sodium nitrate flux to remove antuimony and lead and obtain a product containing 99 per cent. of gold and silver. (See Specification No. 425,648, of E. L. W. Byrne.)

Case-Hardening

A CASE-HARDENING composition comprises pulverised coal 10 lbs., caustic soda 1 lb., barium carbonate 1 lb., and water 12 lbs. The ingredients are mixed together with water to the consistency of treacle and the articles to be hardened are dipped into the viscose compound and the coated articles are then packed into boxes and heated in a muffle or placed direct in the furnace which is then heated to about 900° C. (See Specification No. 425,724, of Moss Gear Co., Ltd., W. Duckitt, F. H. Goode.)

Resistant Alloys

ARTICLES which must, in use, withstand the attack of gases that attack and remove carbon, such as apparatus or parts thereof used in the destructive hydrogenation of oil or coal or in the synthesis of ammonia, are made from non-austenitic steel alloys which contain zirconium or thorium or both, with or without titanium, up to a total of 5 per cent., and, if desired, one or more of the elements silicon, manganese, nickel, cobalt, chromium, tungsten, molybdenum, and vanadium. (See Specification No. 425,073, of Krupp Akt. Ges.)

Coating with Metals

CONDUCTING surfaces are formed on resistances of sintered semi-conducting material, such as oxides of chromium, manganese,, or uranium, by applying a paste containing the electrode metal before the resistance is sintered. The paste consists of glue, collodion, paraffin, etc., containing iron, cobalt, nickel, copper, silver, molybdenum, or tungsten in metallic form or as an easily reducible compound. The resistance may be partially sintered before applying the paste, after which the full sintering temperature is applied. (See Specification No. 424,930, of Patent-Treuhand Ges. Fur Elektrische Gluhlampen.)

Extracting Iron

IN the extraction of metals and metalloids from their oxides, carbonates and silicates, the compounds and carbon or carbon monoxide are brought into reaction at a temperature of 300° to 1,000° C., with the halogen compound of the corresponding metal and the high-molecular halogen compounds so produced are decomposed at a temperature of 700° to 1,500° C., into the metal and a reciprocal halogen compound which may be used over again. The process may be applied to the preparation of alkali metals, such as sodium, alkaline-earth metals including magnesium and beryllium, aluminium and the heavy metals such as copper, nickel, iron, zinc, lead and cobalt. (See Specification No. 425,835, of Epp, K. Mittelbiller-.)

United States Copper Industry

Improved Conditions for 1934

CONDITIONS in the copper industry in the United States in 1934 showed some improvement over 1933. Domestic mine and smelter production were higher than in the preceding year, but in 1933 activity at both mines and smelters was at the lowest level in more than thirty years. Stocks at smelters and refineries were substantially reduced and the average price for copper improved during 1934. Imports into the United States made large gains, although over 90 per cent. of the quantity imported was for treatment under bond and export. Domestic refinery production from imported ores and unrefined materials was strikingly higher in 1934 and was almost as large as output from domestic sources, and the proportion of refined copper from foreign materials to that from domestic sources was the highest ever shown by the statistical record.

The smelter production of primary copper from domestic sources during 1934 amounted to 488,454,107 lb., an increase of approximately 9 per cent. The value of smelter production increased approximately 36 per cent. in 1934. The total production of new refined copper in 1934 was 891,000,000 lb., an increase of 149,000,000 lb., or 20 per cent., over that in 1933.

Metallurgical Section

August, 3, 1935

The Definition of "Cast Iron" and "Steel"

THE July issue of the "Bulletin of the British Cast Iron Research Association" contains a report by Dr. A. L. Norbury, on the definition of the terms "Cast Iron" and "Steel." This subject has been discussed at international conferences, in the law courts and in numerous papers by metallurgists of all nationalities, and the development of low carbon alloyed cast irons has now increased the need for some recognised dividing line. The best method appears to be to fix this in terms of the presence or absence of eutectic. Definitions of the terms in this manner, together with definitions of one or two other terms, are given by Dr. Norbury as a basis for discussion.

Alloys of iron and carbon (other than malleable cast iron) with or without other elements, which do not contain carbide eutectic or graphite eutectic in the microstructure, are defined as "steels." The "cast irons" are alloys of iron and carbon with or without other elements, which contain carbide eutectic (white cast iron) or graphite eutectic (grey cast iron) or both carbide eutectic and graphite eutectic (mottled cast iron) in the microstructure. "Malleable cast iron" is the product obtained by eliminating the carbide eutectic from solid white cast iron by decarburisation (white-heart) or by conversion into graphite by annealing (blackheart). Pigs of cast iron whose chemical analysis and structure have been modified either before solidification from the blast furnace or by treatment involving remelting are "refined pig iron." The use of the term "semi-steel" should be abandoned.

By a series of extracts from the literature it is shown that suggested definitions—as summarised by Dr. J. W. Mellor in his "Comprehensive Treatise on Inorganic and Theoretical Chemistry," 1932, have been in terms of structure, origin, malleability and composition. Even though some of the definitions are reasonably satisfactory when applied to unalloyed steels and cast irons, none of them can be satisfactorily used for alloyed steels and cast iron. For instance, a comprehensive definition in terms of malleability is not possible, since, for example, 4 per cent. silicon steel for transformer sheets is brittle and has no appreciable elongation, while certain austenitic cast irons are comparatively ductile, giving several percentages of elongation in tensile.

A definition in terms of origin also has to overcome difficulties such as the fact that cast iron rolls are cast from open-hearth furnace melts, or that carbon steels can be cast from cupola melts. A definition in terms of composition, taking 1.7 per cent. carbon content as the dividing composition, is satisfactory for unalloyed carbon steels and cast irons and has been extensively adopted. To apply this definition to alloyed steels and cast irons is, however, entirely incorrect. The 1.7 per cent. carbon content in the case of unalloyed steels and cast irons represents the maximum solid solubility of carbon in iron and consequently the carbon content which divides iron-carbon alloys containing no eutectic from those containing eutectic in the structure. When, however, alloying elements which dissolve in iron are present, they lower the solid solubility of carbon in iron and the figure of 1.7 per cent. carbon is progressively lowered as the amount of alloyed element is increased, some elements lowering the solubility much more than others.

Manganese has no appreciable effect on the 1.7 per cent. maximum solid solubility of carbon in iron. Silicon lowers the solubility to less than about 0.1 per cent. carbon for silicon contents of about 8 per cent. and upwards. Nickel lowers the solubility to about 1.4 per cent. carbon with 10 per cent. nickel and to about 1.2 per cent. carbon with 20 per cent. nickel. Chromium lowers the solubility to about 1.1 per cent. carbon with 10 per cent. chromium and to about 0.8 per cent. carbon with 20 per cent. chromium. A definition for alloyed steels and cast irons which is based on carbon content must consequently take into account the lowering by alloying elements of the 1.7 per cent. carbon content of the dividing composition. This is, however, not always done, as indicated in a letter which Dr. Norbury contributed to "The Metallurgist," January, 1932.

Patent Application Difficulties

In this letter he stated that there are no accepted definitions which can be utilised to decide upon the dividing line between steels and cast irons in cases where appreciable quantities of elements such as silicon and nickel are present. In the case of low silicon, unalloyed steels and cast irons, it is generally agreed that steels lie in the range of carbon contents between 0 per cent. and 1.7 per cent. carbon, while cast irons lie in the range above 1.7 per cent. carbon. Unfortunately, however, this figure of 1.7 per cent. carbon is apt to be applied, by persons without the necessary metallurgical knowledge, to all compositions of cast iron and steel. Difficulties have arisen, for example, in taking out patents, on account of Patent Office officials in certain countries arguing that all ferrous alloys containing less carbon than 1.7 per cent. were steels. This is, of course, incorrect, since, as the silicon content increases, the liquid and solid solubility of carbon in iron progressively decreases. For example, the eutectic carbon content falls progressively from 4.3 per cent. carbon with 0 per cent. silicon to about 1.8 per cent. carbon with 10 per cent. silicon. Similarly, the maximum solid solubility of carbide in iron is 1.7 per cent. with 0 per cent. silicon, but the maximum solid solubility of graphite has fallen to 0 per cent. with 10 per cent. silicon.

The effect of silicon in lowering the liquid solubility of carbon in iron may be illustrated by the fact that

12 per cent. ferro-silicon as made in the blast-furnace, or as remelted in the cupola, tends to contain about the eutectic carbon content of 1.5 per cent. carbon, but is obviously a cast iron rather than a steel. In order to define the dividing line between steels and cast iron, as the silicon content increases it is suggested that it is most convenient to use the 1.7 per cent. carbon with 0 per cent. silicon division as a basis. This 1.7 per cent. carbon figure represents the maximum solid solubility of carbide in iron containing 0 per cent. silicon. Irons having carbon contents in excess of 1.7 per cent. contain eutectic in the as-cast condition. Consequently, on this basis, the definition would be that cast irons are those iron-carbon alloys which contain carbide eutectic, or graphite eutectic, in the as-cast condition, while steels are those which do not contain such eutectic.

Definitions in terms of structure appear to be the most exact (by microscopic examination) and such definitions are not impracticable, since all except borderline cases can be decided in terms of solid solubility composition figures of the type given above. The suggested definitions now given by Dr. Norbury are consequently in terms of structure and also specify that steels are iron-carbon alloys, to exclude pure iron and wrought iron.

New Honour for Sir Robert Hadfield.

SIR ROBERT HADFIELD is to be congragulated in being this year's recipient of the Albert Medal of the Royal Society of Arts, " for his researches in metallurgy and his services to the steel industry." The Albert Medal, which is the premier award of the Royal Society of Arts, is given annually " for distinguished merit in promoting arts, manufactures or commerce." It commemorates the work of the Prince Consort, who for eighteen years was president of the Society, and to whom the success of the Great Exhibition of 1851, organised by the Society, was largely due. The award is made irrespective of nationality, and the list of former recipients of the medal includes many leading scientists, inventors and other benefactors of humanity. Seventy-five awards have now been made, of which nineteen have been to workers outside Great Britain. The first Albert Medal, awarded in 1864, went to Sir Rowland Hill for his reform of the postal system of Great Britain. In 1866, Michael Faraday was the recipient. Metallurgists who have received the medal, include Bessemer, Siemens, John Percy and Isaac Lowthian Bell.

Electro-deposition in Industry

LORD MELCHETT opened a special Electro-deposition Exhibition at the Science Museum last week. This exhibition has been designed to illustrate all the phases of electro-deposition and the scientific principles upon which it is based, and it will remain open until the end of October. The exhibition has been organised by the Electro-depositors' Technical Society. Valuable help in its preparation has been given by the British Non-Ferrous Metals Research Association, the Research Department at Woolwich, the Royal Mint and leading industrial firms.

Nearly all metals can be deposited from suitable solutions by the application of an electric current, electroplating being a familiar and important branch of this electro-chemistry. Certain electro-deposition processes are known to have been carried out in the early years of the 19th century, but the subject was first investigated systematically by Michael Faraday (1791-1867), who laid the foundations of the modern science of electrochemistry. The invention of the dynamo about a hundred years ago, by providing a cheap and convenient source of electricity for the first time, paved the way for the large scale application of electro-chemistry to industrial requirements. To-day electro-deposition is indispensable to every-day needs and its practical importance in beautifying common metals and in rendering them less susceptible to tarnish and corrosion is demonstrated at this exhibition. The production and refining of metals by electrolytic means is an industry in itself, the extent of which may be gauged from the fact that the quantity of electrical power used in the electrolytic extraction and refining of metals has exceeded 11,000,000,000 kilowatt-hours per annum, a prodigious total equalling that supplied by all authorised undertakings in the United Kingdom in providing the public with electricity.

Stress and Corrosion

EXHAUSTIVE research on the effect of torsional stress on the rate of corrosion of steel wire by spraying the wire with a solution of potassium chloride, with or without potassium chromate, has recently demonstrated the inhibiting effect of chromates, and that there is no marked difference in stressed and unstressed specimens (" Engineering," *138*, 79). Microscopical examination proves, however, that in the case of the unstressed specimens there are a few large pits of intense corrosion, with a large proportion of unchanged surface, whilst in the case of the stressed specimens there are numerous small centres of corrosion, with little unattacked area. This difference, according to Mr. A. J. Gould, is attributed to the rupture of the primary film during each application of stress. Preferential attack along narrow fissures resulting from alternating stresses is stated to cause premature failure, although the loss of weight and diminution of electrical conductance may be no greater than in the unstressed specimens exposed to the same corrosive medium.

The Moscow Steel Institute

WITH its teaching work, the Moscow Steel Institute also carries on research. In 1932-33, it conducted large-scale experiments on the utilisation of new chrome-nickel ferrous ores from the Khalilovo deposits. In 1934, the electro-metallurgical laboratory carried out work on the casting of ferrous alloys not previously cast in the Soviet Union. It also discovered a method of obtaining carbon-free ferrous-chrome from Soviet raw materials, and the results of this work have been practically applied in industry. Similiar experiments are now being carried on with a view to obtaining other ferrous alloys. Special reports on the most important of the research projects of the Institute carried out since the end of 1934, will shortly be published to enable other institutes and works to make use of them. Future Soviet engineers receive an appointment to a plant, or to their future place of work, one year before finishing their course at the Institute. Each student passing into his fifth year therefore knows exactly where he will work on leaving. The student carries out practical work for the diploma in the plant to which he is assigned for his last year, and his graduation thesis is based on the conditions of work at that particular plant.

The Prevention of Corrosion by Acids

A Study of the Use of Inhibitors

THE literature of metallurgy and related sciences during recent years abounds with references to the use of addition agents in acid solutions for the purpose of controlling or preventing the solution of metals. In the effect on the rate of hydrogen displacement from the solution, this use of inhibiting addition agents closely resembles the use of colloids in the electric-deposition of metals for increasing current efficiency and for promoting smoothness in the deposited metal, said Mr. V. A. Wardell, B.Sc., in a paper presented to the Chemistry Section of the Australian and New Zealand Advancement of Science, January, 1935.

The typical modern inhibitors are heterocylic organic compounds of relatively high molecular weight, such as quinoline and its series, but probably the oldest and best known are glue and starch. Simple and very powerful inhibiting effects are sometimes obtained from the presence of arsenic or antimony in solution, traces of nitric acid in sulphuric acid, and chromates, etc., in brines and acid waters.

Use of Inhibitors in Pickling Operations

The study and use of inhibitors has been very largely concentrated in the art of pickling iron and steel in various forms. While the primary purpose of pickling is the removal of scale, it is also necessary in certain cases to leave the exposed surface in a suitable condition in respect to cleanliness and etching for subsequent processes. It is generally recognised that scale is largely not dissolved by pickling solutions, and the usual explanation of the action was that the scale was removed by the mechanical action of the hydrogen evolved by acid attack on the underlying steel surface This would pre-suppose that some attack on the steel was necessary to the removal of scale, but it is now known that a predominating reaction is due to the heterogeneity of the scale structure, the outer portions of Fe_3O_4 or Fe_2O_3 being relatively unaffected by pickling solutions, but the inner portions of FeO, directly attached to the steel, are relatively easily dissolved. This gives the mechanical detachment of the bulk of the scale.

It is reasonable to believe that the evolution of hydrogen must assist the work of scale removal to some extent, but both laboratory and works observations show that pickling proceeds under conditions of extreme inhibition without apparent evolution of hydrogen. It is, however, true that the use of inhibitors slightly retards the speed of pickling.

Some Conflicting Evidence

The advantages of inhibitors in pickling are (a) economy of acid and steel, (b) reduction in the embrittlement effects of diffused hydrogen in the steel itself, (c) in certain cases a great reduction in the fume or spray from the pickling tanks, and (d) some reduction in certain maintenance costs. The last of these is purely incidental, but the third, although often incidental, is sometimes the deciding factor in the choice of an inhibitor. The economy attainable in acid and steel consumption may be very large, and for purposes of illustration may amount in special cases to 1 per cent. of the total steel treated and perhaps 30 or 40 lb. of mono sulphuric acid per ton of steel. However, the amount of inhibitor that can be used is frequently limited by specific requirements of the processes following pickling, and in certain types of galvanised sheet work the maximum inhibitor addition is comparatively small.

On the effect of inhibitors in minimising the diffused hydrogen in the steel there is some strongly conflicting evidence The theory of these effects is in a most unsatisfactory and incomplete state, but for directness it may be simply stated that during acid corrosion of iron and steel some of the hydrogen diffuses into the metal in atomic form, and where there is any discontinuity in the steel, such as inclusions, blowholes, etc., it will be evolved in molecular form. Where one side of the steel piece is not in contact with the acid, some hydrogen gas will escape freely. This hydrogen can build up very great pressures, it having been found that the evolution of hydrogen, after diffusing through a sheet, would continue against a pressure of 14 atmospheres.

Apart from direct blistering of the steel this diffused hydrogen may produce blemishes in subsequent operations, such as enamelling, galvanising and tinning, as it will escape very freely when the steel is warmed, and cause eruptions in the coatings on the metal. A further effect of the hydrogen, which remains in the steel in atomic form, is a marked reduction in ductility and even extreme brittleness. This brittleness is more notable in medium or high carbon steels, but can perhaps be over-emphasised as it is ephemeral and can be rapidly corrected by warming to 200° C. or less.

Inhibitors are very efficacious in reducing or preventing pickling blisters and coating defects, but the evidence on embrittlement is conflicting. There is, however, definite evidence that, after pickling under similar conditions with and without an inhibitor, much more hydrogen remains in the steel in the latter case than in the former, and it is reasonable to assume a reduction in tendency to embrittlement with the use of inhibitors. This tendency to pickling embrittlement may be expected to affect profoundly cases of corrosion fatigue, and any such embrittlement should greatly aid the formation of surface cracks under conditions of stress and movement.

Glue to the extent of 0.15 per cent. in 10 per cent. sulphuric acid causes a negligible reduction in embrittlement although the acid attack was greatly retarded, and there was hardly any evolution of hydrogen. Pyridine and quinoline give appreciable reduction in embrittlement, when additions of 2 per cent. are used.

Substances Covered by Patent

In view of the very strong inhibiting powers possessed by some common and relatively cheap substances, it is difficult to justify the astonishingly long list of substances covered by patent rights. Some are known to be more powerful, weight for weight, than others, but as they may be used in extremely small concentrations, and the cost, in the case of glue, for example, is usually negligible, there is not much to be sought in most applications in the direction of economy of purchase. There are, of course, special circumstances to which the general case is not applicable; for example, in testing or analytical work, where storage in concentrated acids is required, for foaming or for long maintained efficacy in a batch process. Known inhibitors include :—

Glue, gelatine, etc.—Perhaps the best known and the most generally encountered in published experimental work, and is used extensively in pickling practice.

Starch.—Much greater quantities required than in the case of glue, rapidly hydrolysed, and not used in modern practice.

Pyridine, quinoline, etc.—The larger compounds are very efficient and the basis of much experimental work.

Naphthalene sulphonic acid.

Anthracene oils.

Glycerine.

Aldehydes.

Hydroxylamine.—U.S. Pat. 1,723,923.

Alcohols and Ketones.

Sulphite pulp liquor.

Thio glycollic acid.—Eng. Pat. 357, 387.

Tri thio formaldehyde.—U.S. Pat. 1,805,052.

CS_2, derivative of a reaction product of an aldehyde and a guanidine. U.S. Pat. 1,868,214.

Thio urea compound.—U.S. Pat. 1,734,949.

Stannous chloride.—Used both in ordinary pickling and in electrolytic pickling.

Sodium chloride.—Has been shown to give inhibiting hydrogen diffusion, and to inhibit equally the corrosion of the steel.

Arsenic is an extremely effective inhibitor in acid corrosion of steel, and, apart from other undesirable features, it has been found impossible to pickle steel effectively (in cases requiring a certain amount of acid etching of the steel), in the presence of more than small traces of this element. The presence of arsenic to the extent of 0.0055 per cent. in the acid is not far from the upper limit as it abstracts the pickling action. For the same reason, contracts for the supply of sulphuric acid for pickling have been made both in England and in Australia, specifying a maximum arsenic content of 0.0008 per cent.

General indications are that the organic inhibitors have a more or less universal effect in reactions between solids and liquids, the effect being generally greater on the solution of metals than on the solution of calcite or iron oxides. Arsenic, while a powerful inhibitor of the solution of iron in acid,

is an accelerator of the solution of zinc in acid. The action of the organic compounds applies to both acid and alkaline solutions as well as solutions of calcium chloride, and has been illustrated for several metals.

Rhodes and Kuhn ("Ind. Eng. Chem.," 1929, *21*, 10, 66) observed the corrosion of metals in a 25 per cent. solution of calcium chloride for eight days at 22° C. and at 60° C. In one series no inhibitor was present and in the other the solution was saturated with crude quinaldine. Their results are stated as follow:—

Inhibiting Powers with Calcium Chloride—per cent.

Metal.	22° C.	60° C.
Aluminium	59	77
Copper	0	39
Iron	10	42

The authors state that all these values are much lower than the 82.3 per cent. efficiency of crude quinaldine as an inhibitor of the corrosion of iron by sulphuric acid at 60° C. This may be due in part to the limited solubility of quinaldine in solutions of calcium chloride. They further state that over a period of 95 days at room temperature 3, 6-dimethyl-2, 7-diamino acridine ethylchloride has an efficiency of 39 per cent. in inhibiting the corrosion of iron in a 25 per cent. solution of calcium chloride.

Inhibition in Alkaline Solution

Inhibition in alkaline solutions has been studied by Rhodes and Berner ("Ind. Eng. Chem.," 1933, *25*, 1336) using aluminium as the test metal, an important part of the work being that they checked the effect of the inhibition on *p*H as well as on corrosion rates. It is unfortunate that results are reported only for comparatively high concentrations of the two substances showing strong protective action—one, glucose showing complete protection in molar concentration in molar caustic soda, and, gelatin being as follows, expressed on the same basis as previous figures, in molar solutions of NaOH:—

Gelatin per cent.	*p*H	Inhibiting Power per cent.
0.0	13.58	—
2.0	13.39	60
4.0	—	84
6.0	13.39	88

Among the organic compounds of similar types Rhodes and Kuhn ("Ind. Eng. Chem.," 1929, *21*, 10, 66) found a general increase in the inhibiting power with increasing molecular weights, and this increase is greater than the percentage increase in molecular weight. They give an empirical equation $I = M/16^{1.38}$ to express the relationship for methyl derivatives, with one exception noted below. They state that the introduction of methyl, phenyl or hydrogen groups decreases it. The effect of the position of the group is illustrated by an inhibiting power of 53.9 per cent. for 2-methyl quinoline and 59.7 per cent. for 6-methyl quinoline.

Increased Inhibiting Power

With regard to the relationship deduced for increasing molecular weight and inhibiting power, it should be noted that if all the experimental work had been done with equimolar concentrations the relationship might, with equal virtue, have been interpreted as a simple mass concentration effect, and need not have invoked at all the molecular concept. In certain cases, however, inhibiting power was also determined at 100 millimols per litre (the rest of the work being at 10 millimols). The results obtained show that inhibiting power is not a function of the weight concentration of these compounds used, but is governed by additions to the molecular structure. An illustration is quinoline at 100 millimols, or 12,900 mgm. per litre, with an inhibiting power of 84.6 per cent. against 91.2 per cent. for B naphtho-quinoline at 10 millimols or 1,790 mgm. per litre.

Several workers have stressed the effect of certain inhibiting actions in giving a generally lower corrosion rate, but causing concentration of the attack at isolated points with resultant pitting. Rhodes and Berner ("Ind. Eng. Chem.," 1933, *25*, 1336) refer to this effect of sodium silicate as an inhibitor in alkaline corrosion of aluminium, and U. R. Evans ("J. Soc. Chem. Ind.," 1925, *44*, 163 T) discusses very fully the promotion of water line attack by the presence of chromates and carbonates as inhibitors of the general saline corrosion of iron. The latter case is, of course, governed by the supply of oxygen from the air, and therefore differs essentially from the cases previously discussed. All the experimental work described in this paper refers to conditions of total immersion, and instances of localisation have not been reported.

The Electrolytic Refining of Lead

Some Modern Changes in Technique

THE process of refining lead by electrolysis represents one of the few systems where severe competition is experienced from pyro-metallurgical methods. Recent years have seen smelting methods slowly but consistently improved on, and in some cases completely substituted by electrolytic means. This condition does not apply in the same way when dealing with complex mixtures of metals which are the by-products of different metallurgical operations, but the electrolytic system can often offer a "short cut," which otherwise would be unobtainable by smelting methods.

The smelting of lead was for long retarded by the heavy temporary losses sustained by volatilisation of the "fume." The wet and dry systems of recovering the latter have since been obviated by the electrostatic process, which did much to assist the continuance of smelting methods in this line generally. Meanwhile practical experience with different electrolytic refining processes proved that scope for development was somewhat limited. So far as the recovery of lead from scrap metal is concerned, electrolytic methods have not been a success economically. Where most success has been experienced is in the electrolysis of bismuth-bearing lead, lead-bullions, and metallins. The latter represent complex mixtures of metals, existing exclusively in the metallic condition, and which give rise to somewhat complicated and protracted methods of separation. It will thus be observed that unless other constituents are present to justify the introduction of the electrolytic process, the actual electrolysis of lead by itself will not be an economical success.

In the case of bismuth-bearing lead and lead-bullions the principal constituent is lead, so that any direct means of separating the latter is of the greatest importance. The principal use of lead electrolytic processes is for the latter purposes. The margin permitting the innovation is again a small one, as, on the one hand, cupellation is used to separate lead from rich lead alloys, and bismuth may be directly separated from lead by an improved smelting method.

Whereas many other electrolytic systems permit of a more or less direct means of applying the process, the same cannot be said of lead electrolysis. The besetting sin experienced in lead electrolysis is the manner in which the lead forms its deposit on the cathode. Irrespective of the nature of the electrolyte employed, there is always a tendency for unexpected crystalline growths to develop. These generally spread out as the process proceeds until they reach the anodes, with the result that short-circuiting ensues.

Apart from the practical difficulties involved in handling a process of this type, the nature of the lead produced is such that it requires some final treatment before it can be placed on the market. A considerable number of addition agents were tried to overcome this spreading of the growth, and, although success has been largely attained, it has to be recognised that when dealing with some fresh class of alloy the lead does not always deposit smoothly and coherently. The addition agents successfully used within the past few years have been gelatine, peptone, eugenol, and clove-oil.

The electrolytes used were fluosilicic, fluoboric, and mixtures of different fatty acids with sulphuric acid. Whilst these ensured the necessary high electrical conductivity, the

work was limited to more or less pure forms of lead anodes. In order to depend on smooth deposits and consistent operation it was desirable that the lead content did not fall below 97 per cent.

Complex alloys of lead were thus not suited for this class of process, and it was found necessary to materially modify the conditions. Lead alloys rich in zinc, iron, and nickel caused an accumulation of salts of these metals in the electrolyte, and, instead of the process proceeding as it had started, a fresh electrolyte had to be substituted to make the system workable. For this reason, the lead had to be partially refined, prior to casting into anode form.

Incidentally this preliminary refining had the advantage of removing tin which by the foregoing process would otherwise have tended to contaminate the deposited lead. In other words, the earlier lead electrolysis made provision for leads containing bismuth and precious metals only.

Lead is deposited on the cathode from anodes containing relatively high percentages of tin and antimony in the form of an alloy, and it was this feature which led to the production of solder and type metal by this system. Previously antimony, bismuth and other impurities were included in the slimes which accumulated during the progress of the electrolysis.

The anodes from the smelting process could either be simply composed of bismuth-bearing lead or lead bullion—or on the other hand, metallins or alloys containing appreciable proportions of other metals. The voltage is dependent on the spacing of the electrodes, the amount of impurities in the electrolyte, and the current density which is employed. It is doubtful if the difficulties sustained in operating the original Betts process were fully appreciated, as it was necessary to work with anodes of slightly smaller dimensions than the cathodes, and anodes which were wedge-shaped.

The troubles with coarsely-crystalline deposits are to-day almost entirely eliminated, and the addition agent literally constitutes a recognised portion of the electrolyte. The original current density used by the Betts process seldom exceeded 18 amps., but to-day this input has been more than doubled. Although tin and antimony may be caused to enter the lead, there is no indication of the current depositing other impurities present in the anodes on to the cathodes, and hence the process is an advance on earlier systems of electrodeposition.

Application of X-Ray Diffraction Patterns to Metallurgy

Investigations at the National Physical Laboratory

THE investigation by X-ray spectrometry of structural changes produced by the cold working of metals was a feature of the work of the Physics Department at the National Physical Laboratory during 1934. Previous X-ray work has shown that when a metal is cold worked (rolled, for example) there are three stages in the process. The first stage in the rolling results in a breaking up of the crystallites until they reach a linear size of the order of 10^{-3} to 10^{-4} cm. Further rolling or other form of cold work produces structural changes which are characteristic by a broadening of the lines in the X-ray diffraction pattern. The third stage is the production of fibre structure or selective crystal orientation, in which the individual crystallites tend to orient themselves so that certain crystallographic directions coincide approximately with the directions characteristic of the cold-work process (*e.g.*, direction of rolling, direction of drawing, etc.). The broadening of the lines has been attributed, on experimental grounds, to a distortion of the atomic arrangement in the metal crystallites, which in turn has resulted from the stresses imposed by the cold working. This effect appears to be associated most closely with the changes in physical properties which also accompany cold work.

Magnet Steels

In previous annual reports of the National Physical Laboratory it has been shown that the presence of a large amount of internal strain is in general a characteristic feature of the structure of a high-grade magnet steel, and that processes, such as suitable heat treatment, which tend to remove such strain, result in a lowering of the magnetic quality. X-ray studies of the effect of heat treatment on materials, such as tungsten and cobalt steels, have indicated that the carbon in such steels plays an important part in the production of the internal strain which is measured by the broadening of the diffraction lines. Arrangements have been made for a more detailed study of the effect of variations in the chemical constitution on the maximum amount of strain which can be introduced in the crystal lattice and the corresponding changes in the magnetic properties of the steel.

In special permanent magnet materials, such as nickel-aluminium steels, where no carbon is present, other factors appear to influence the magnetic quality. Preliminary X-ray investigations of such steels show that the structure characteristic of magnetic material with high coercive force and remanence is one in which the nickel and aluminium atoms do not replace the iron atoms in a random manner, but in a regular way, so as to produce a type of super-lattice structure.

X-ray work on steels used as cores for electrical transformers has proved that satisfactory material is characterised by a structure in which the individual crystallites are free from internal strain. The annealing treatment which results in the removal of strain leads in general to a growth in the size of the crystallites, but this growth is not necessarily a good feature, since it may tend to an increase in eddy current losses. Further work has confirmed these results. Thus X-ray work on nickel-iron alloys of high initial permeability has shown that the best material has a structure in which the crystals, although relatively small, give X-ray reflections corresponding to a high order of perfection. It is believed that silicon steels can be obtained with better magnetic properties if their component crystallites are kept relatively small and as perfect as possible.

Crystal Lattice Distortion

In investigations already carried out at the Laboratory it has been shown that in most metals cold-work processes result in a broadening of the X-ray diffraction lines, which has been interpreted as evidence for the existence of strain and distortion in the crystal lattice. Measurements of the amount of the broadening give an estimate of the amount of this internal strain, and it has been shown that the electrical, magnetic and tensile properties of the metal vary with the state of perfection of the crystals measured in this way. In extension of this work, detailed studies have been made of the effect of cold rolling of the structure of alpha-brass.

Quantitative measurements from diffraction pattern photographs indicate that there is a smooth relation between the increase in hardness and the breadth increase. The lines do not broaden symmetrically about the position of the undistorted line, but the greater part of the broadening occurs on that side of the line which would indicate an increase in the size of the unit crystal cube. It would appear from this work that the strain hardening results from the distortion of the crystal lattice, and that the breadth of the X-ray diffraction lines can be used as a measure of the strain-hardening effect.

Diffraction Patterns for Wires

Further studies have been made on the changes in the X-ray diffraction patterns of wires before and after they have been stretched by progressive loading. Wires of copper, nickel, alpha-brass and constantan have been examined. In each case similar effects were found. As the load on the wire is increased the diffraction lines broaden; the broadening, small in the early stages, grows rapidly in the neighbourhood of the yield point, and continues this relatively rapid rate of increase until fracture occurs. Measurements of the breadth of the lines at the point corresponding in fracture show that it is of the same order of magnitude as the maximum breadth observed in experiments with other methods of cold work, such as rolling or drawing. The results lead to a method of estimating the degree of lattice distortion, and therefore of internal strain, present in a given metal specimen.

Some Recent Metallurgical Patents

Dephosphorising Steel

IN a process for dephosphorising steel which is relatively poor in phosphorus, and containing a quantity of oxide sufficient to bind the phosphorus, the molten steel is intermixed with a molten sufficiently fluid basic non-reducing slag which contains very little or no oxidising agent with such violence that an emulsion-like and turbulent mixture of metal and slag is produced. The process may be carried out as described in Specification No. 405,633, and the slag used comprises mainly lime and magnesia with the addition of fluxes such as spar alumina, soda, etc., and contains a minimum of silica. A slag comprising 17 per cent. of silica, 8.32 per cent. of alumina and the remainder lime and magnesia is referred to. (See Specification No. 427,466, of Soc. d'Electrochimie, d'Electro-Metallurgie, et des Acieries Electriques d'Ugine.)

Treating Metallic Surfaces

A BATH for use in forming phosphate coatings on iron or steel and which initially contains one or more acid phosphates and a nitrate of an alkali metal is replenished by the addition of an acid phosphate or phosphates and a nitrate of one of the elements magnesium, calcium, barium, strontium, manganese, zinc, cadmium and iron, which elements enter into the coating as phosphates. The preferred bath is formed by dissolving manganese dihydrogen phosphate and sodium nitrate, with or without a soluble copper compound such as copper carbonate, and is replenished by the addition of manganese dihydrogen phosphate and manganese nitrate. The manganese nitrate is preferably added in admixture with normal or mono-hydrogen manganese phosphate and a copper compound may be added with the manganese dihydrogen phosphate. (See Specification No. 427,921, of Metal Finishing Research Corporation.)

Nitrogenising Alloy Steels

ALLOY steels are nitrogenised by immersing them in a fused salt bath containing an alkali metal cyanamide such as sodium cyanamide, the bath being free from substantial amounts of alkaline earth compounds and having a temperature below 600° C., preferably 500° to 550° C. The salt bath contains also inorganic salts which do not react with the cyanamide and which lower the melting point of the mixture, such as sodium and/or potassium cyanide or a low melting mixture of lithium, sodium and potassium chloride. Access of air to the bath during the nitrogenisation may be prevented by covering the bath with a layer of finely-divided graphite or charcoal. In an example, an alloy steel containing 1.24 per cent. of aluminium, 1.58 per cent. of chromium, 0.51 per cent. of manganese, 0.2 per cent. of molybdenum, 0.33 per cent of carbon, and 0.20 per cent. of silicon was immersed in a salt bath composed of about equal parts of potassium cyanide, sodium cyanide and sodium cyanamide at about 538° C. (See Specification No. 426,207, of E. I. Du Pont de Nemours and Co., and D. A. Holt.)

Refining Copper

IN a process for refining copper in which a copper matter is first produced, *e.g.*, in a reverberatory furnace, and afterwards treated in a converter, the amount of iron sulphide in the charge of molten matter is regulated to a point at which blowing will be associated with a rise of temperature sufficient to volatilise the bismuth present in the matter and the charge blown so as to effect such volatilisation in the early stages of the blowing before material amounts of metallic copper are present. Cold cuprous material may be added after the volatilisation to regulate the temperature of the bath. The smelting in the furnace is carried out so that a sufficiency of iron sulphide, *e.g.*, of the order of 5 per cent., is left in the matte before the blowing or, if the ores contain a large quantity of iron sulphide, the ore may be roasted or iron oxide added before smelting in the furnace. If the ore does not contain an excess of iron sulphide, the tendency in the furnace to eliminate a portion of the sulphur may be counteracted by the addition of a reducing agent such as coal or iron sulphide to the charge. (See Specification No. 426,721, of Roan Antelope Copper Mines, Ltd.)

Cementation

In using cementation baths containing cyanides, the alkaline substances formed by the decomposition of the cyanides are rendered innocuous by the addition to the melt of silica or of alkali-fixing non-volatile acids or salts, such as silicic acid, boric acid, phosphoric acid, phosphates or silicates. The agents may be added to the melt gradually and uniformly, or intermittently, or, in the case of silica, at the start; they may be added along with the fresh supplies of cementation agent which are added from time to time to replenish the bath. (See Specification No. 424,003, of Deutsche Gold-Und Silber-Scheideanstalt Vorm. Roessler.)

Zirconium Alloys

IN making zirconium alloys by reduction with carbon in an electric furnace, the charge of silica and zirconium ore or compound is first so proportioned that a zirconium-silicon alloy containing more zirconium than silicon is produced, whereafter, in the presence of the zirconium carbide which has accumulated in the furnace, there is reduced a charge of such composition that a zirconium-silicon alloy containing more silicon than zirconium is produced, the zirconium carbide being thereby removed from the furnace. The charge in the second part of the process may be a mixture of silica and zirconium ore or compound, or if rapid removal of the zirconium carbide is desired it may contain no zirconium ore or compound. (See Specification No. 427,076, of Electro Metallurgical Co.)

Fluxes

A SLAG-FORMING compound for arc welding contains a higher oxide of a metal or metals capable of forming at least one lower oxide and manganese or an alloy thereof such as ferro-manganese in sufficient amount to reduce the higher oxide only to the lower oxide by reaction at welding temperature. The oxide may be magnetite or manganese dioxide or a mixture of both. The slag produced provides a concave meniscus at the surface of the deposited metal so as to wet the parent metal and thus to prevent slag inclusions in the weld. One example consists of 150 grams of flint, 75 grams each of manganese dioxide and magnetite, 30 grams of asbestos, 60 grams of 80 per cent. ferro-manganese and 200 c.cs. of sodium silicate, which produces an acid slag containing more silica than a mono-silicate. (See Specification No. 424,960, of A. P. Thurston.)

Copper Oxide Cut-Outs

COPPER oxide cut-outs are made by heating copper at a temperature just below its melting point, preferably about 1,000° C., to form a layer of red copper oxide, and the conditions of cooling are then controlled to give the required breakdown value. The heated metal may be cooled gradually to room temperature, in which case the breakdown value varies inversely with the rate of cooling. Alternatively the heat treatment to form a layer of oxide may be followed by an anneal at a lower temperature, *e.g.*, from 150° to 600° C., the metal being then either cooled slowly to room temperature or quenched. Examples are given in which copper is first heated at 1,010° C. and then annealed at a lower temperature in one case at 150° C. followed by slow cooling and in another at 480° C. followed by quenching, the latter giving a lower breakdown value. (See Specification No. 419,439, of British Thomson-Houston Co., Ltd.)

A New Australian Source of Rhenium

EXPERIMENTAL work is being carried out to determine whether Australian molybdenite contains appreciable quantities of rhenium. The method of extraction consists of (1) oxidising the finely divided molybdenite with nitric acid; (2) removing molybdenum as hydrated trioxide and as ammonium phosphomolybdate; (3) precipitating rhenium and remaining molybdenum as sulphides; (4) converting metals to sulphates and distilling in hydrogen chloride, when rhenium volatilises. Rhenium and its salts have increasing applications and results of this research will be awaited with interest.

Metallurgical Section

September, 7, 1935

Non-Metallic Inclusions in Ferro-Alloys

THE study of the non-metallic inclusions in iron and steel has engaged the attention of steel manufacturers for many years. Recent knowledge tends to show that these inclusions have an important bearing on the quality of steel, but that, in terms of form and numbers in which they occur, it is impossible to assess their influence on the properties of the steel. A paper which Mr. B. Matuschka read before the Iron and Steel Institute at its May meeting has now dealt with the nature and quantity of the non-metallic inclusions in ferro-alloys, which is now a problem of growing importance in view of the steadily increasing use of alloyed and super-alloyed steels.

According to Mr. Matuschka, the globular inclusions are seldom uniform in size. Examined under a high-powered microscope, they are usually found to be surrounded by numerous fine slag vesicles, which remain in suspension in the liquid metal, probably in the colloidal condition. Irregular crystalline inclusions are seldom present in larger forms. They are mostly small and of uniform size, and are generally surrounded by dense, slag-free metal. These inclusions in steel undergo certain modifications by the hot and cold-working to which the metal is subjected. Ductile slags are stretched together with the steel when the latter is worked, without acting detrimentally as foreign bodies, provided that their melting point is not too low and that they are chemically inert to their surroundings. Brittle slag particles, however, if of larger dimensions, can set up cracks when the metal is hot-rolled or forged. They are only partially able to follow the stretching of the steel, and in doing so they break into several parts, between which there are cavities which are more or less filled up with the plastic steel. Very small slag crystals participate only indirectly in the stretching process, being displaced like a floating body by the flowing metal, and so being harmless when the metal is hot-worked. When steel is cold-worked or hardened, or the tool is doing its work, all slag inclusions which are of definite size or are concentrated locally in fairly large groups will be detrimental.

Standard ferro-tungsten, produced in ingot form in the pasty state, often contains a fair amount of slag, the metal being dispersed by coarse and fine vesicular silicate slag particles, especially where the carbon content is low. Low-carbon ferro-tungsten produced by the thermit process also contains numerous vesicular inclusions, since the metal is only liquid for a short time and this period of time is not long enough for the large quantity of fine slag particles which occur to segregate out. Tungsten metal produced chemically, however, is free from slag and in other respects it also constitutes a very pure alloy. Ferro-chromium alloys in low-carbon grades often contain numerous vesicular inclusions. Isolated inclusions exhibit metallic segregations of dendritic structure, or an emulsion between the metal and slag. Generally speaking, these inclusions are chromite/chromic-oxide crystals in a eutectic and partially siliceous ground-mass. Ferro-molybdenum manufactured electro-thermally in ingots frequently contains fairly large quantities of slag inclusions. Produced by the silico-thermal process it usually contains spheroidal silicate inclusions. Molybdenum alloys of this kind, possessing a high degree of purity, are now being marketed, and they contain only isolated inclusions. Molybdenum for commercial purposes is also manufactured chemically, but being very volatile in powder form, this metal is not very suitable for steel manufacture.

The microsection of Mond nickel is perfectly free from slag, except for a few circular zones on the outside of the nickel balls at which fine NiO-slag particles have accumulated; it is therefore very suitable for incorporating in furnace charges. In " cube nickel " the entire cross-section is interspersed by numerous very fine oxide slag particles; these are probably unreduced residues of nickel oxide from the reduction of the nickel oxide cubes mixed with flour. American " cathode-nickel " contains only isolated traces of small nickel oxide inclusions, but the anode plates are very impure and interspersed by numerous fine and extra-fine slag suspensions. In view of the extremely high demands made of cobalt steels, Mr. Matuschka points out that it would be desirable if the quality of cobalt metal could be improved, besides which the big variations in the metal loss which occur when high-cobalt steels are melted would be minimised.

The 50 per cent. ferro-vanadium is fairly pure; the inclusions which occur are very small. The 80 per cent. ferro-vanadium is much less pure, because there seem to be difficulties in separating the slags at the higher melting point. As ferro-vanadium has a low specific gravity and easily oxidises, it is preferable to use the purer 50 per cent. alloy for steel manufacture. Of the ordinary manganese alloys, high-carbon ferro-manganese and spiegeleisen are very free from slag, but when examined under the microscope at high powers, isolated grey oxy-sulphides are noticed—in blast-furnace ferro-manganese more than in the electric furnace product. Despite their low carbon content, the commercial manganese-silicon alloys usually have very few inclusions in them. This is probably due to the manganese silicates being separated more easily—a fact which explains why these alloys have been widely adopted for steel manufacture.

When fairly large quantities of silicon are added to steel as an alloying element, it is essential that it be as free as possible from slag, and the ordinary 45 and 75 per cent. ferro-silicon alloys usually satisfy this requirement very well. Freedom from slag in the steel depends

mainly on the external condition of the alloy, the size of the pieces, their porosity and moisture, the method of making the addition, and the state of the metal bath at the time the silicon is added. Dark grey silicate slags in the form of streaks are often found in the high-silicon alloys. Larger quantities of such slags usually only occur with 90 per cent. ferro-silicons, because, owing to their high melting point, they cannot be manufactured without a certain amount of trouble.

As an alloying element copper is used primarily as an addition element for non-corroding (rustless) steels, for which reason the added copper should be as pure as possible. Even electrolytic copper exhibits fine blue cuprous oxide inclusions under the microscope at suitable magnifications. Where the added percentages are high, particular attention should be paid to the purity of the copper.

Basic Type Ingot Metals

THE American Non-Ferrous Ingot Metal Institute is studying various alloys which may be considered as basic types for the industry. A study has just been completed on the physical properties of red brass containing 82 per cent. copper, 3 per cent. tin, 5 per cent. lead, and 10 per cent. zinc. This alloy is considered to be on the low-copper side of the group of alloys classed by the American Society for Testing Materials as "red brasses" and for which a composition consisting of 85 per cent. copper and 5 per cent. each of tin, lead, and zinc, has been accepted as the basic alloy. The comparison of the physical properties of the modified alloy and the basic alloy, cast under comparable conditions, indicates the modified alloy to be superior in ductility, fluidity, and electrical conductivity, but slightly inferior in yield point and hardness; the difference in tensile strength and in density is very small.

Hardness of Sprayed Metal Coatings

THE conditions necessary for the production of hard metal coatings, with particular reference to sprayed films as obtained by the Schoop process, are discussed by Kessner and Everts in the May issue of "Zeit. Metallk." The authors point out that the hardness of the films depends on the distance from which the metal is sprayed and also on the pressure of the hydrogen in the spraying apparatus; in addition the mechanical control of the wire passing through the spraying pistol is important. The condition of the sprayed film is also affected by the temperature of the metal which is being coated, the ultimate thickness of the film, the amount of time which is allowed to elapse between successive sprayings, and the pressure and oxygen content of the gases burnt in vaporising the metal. Curves are given to show the Ritz and Brinnell hardness of sprayed coating in relation to the distance of the pistol from the material which is being sprayed, and also in relation to the hydrogen pressure and the rate of feeding the wire. Other curves show the relationship between the Ritz hardness and the length of sheet sprayed, in which the scratch width decreases as the length of the sheet increases.

Alloy Steel Gas Cylinders

A NUMBER of alloy steel cylinders which had been used for the storage of compressed coal gas for gas traction purposes for periods of twelve months or more were examined at the National Physical Laboratory during 1934. Some of these cylinders showed definite signs of corrosion at the internal surface, and in one case an appreciable amount of foreign matter was present in the cylinder; this deposit consisted of organic matter, iron and sulphur. Microscopical examination showed that the corrosion partly took the form of preferential attack along the grain boundaries. In other cylinders slight corrosion had also occurred, but the attack along the grain boundaries was not so marked. In no case, however, did the corrosion amount to serious deterioration. One possible cause of corrosion is said to be attack on the steel by carbon monoxide, with the formation of iron carbonyl. Two cylinders which have been used for storing under pressure pure carbon monoxide and mixtures rich in that gas were therefore examined. Definite attack in the form of small cracks, causing flaking at the surface, occurred in the cylinder in which mixtures of gases had been stored, but the cylinder which had been filled with pure carbon monoxide at a pressure of 120 atmospheres for a period of three years had not been attacked to any appreciable extent.

Dental Alloys and Amalgams

THE determination of volume changes occurring during the setting of amalgams made from pure silver-tin alloys, to which varying percentages of copper may or may not have been added, has led to important conclusions in the course of investigations carried out for the Dental Investigation Committee and subsequently recorded in the "British Dental Journal." The composition of the alloy which will produce a satisfactory amalgam is extremely critical. This composition can be directly correlated with the constitution of the alloys, and the determination of the constitution of the silver-tin-mercury system is therefore of importance. The ternary system is very complicated, and in order to explain the effects, a wider range of alloys should be examined. Annealing for many months at low temperatures shows that equilibrium is not likely to be attained readily, if at all. The absorption of mercury, however, seems to take place comparatively easily at the temperature of heat treatment.

Statistics of the Tin Industry

ACCORDING to the August issue of the Bulletin of the International Tin Research and Development Council, the world production of tin in the first half of 1935 was 51,071 long tons, compared with 50,753 tons in the first half of 1934. Of this year's output 40,306 tons, or 79 per cent., were produced by Malaya, Bolivia, Netherlands East Indies, Nigeria and Siam, while 4,582 tons, or 9 per cent., were produced by the Belgian Congo, French Indo-China, Cornwall and Portugal. British Malaya alone produced approximately 30 per cent. of this year's output of tin. The apparent world consumption of tin in the first half of 1935 increased by over 14 per cent. to 67,450 tons, compared with 58,959 tons in the first half of 1934. It is estimated that 27,800 tons of tin were used this year in tinplate manufacture, against 25,400 tons last year, and 9,100 tons in the motor industry, against 7,560 tons. The world output of tinplate in the first half of 1935 was 1,744,000 tons, against 1,580,000 tons in the corresponding period of 1934.

Graphical Studies of Tin Alloys

A Study of Equilibrium Diagrams

WHEN two molten metals are mixed a single uniform or homogeneous liquid alloy is usually formed. The two liquid metals generally dissolve completely in one another, giving a solution in which neither can be seen separately. Sometimes, particularly when a small amount of one metal is added to a large amount of another, the uniform liquid solution, when cooled, gives a solid which is also perfectly homogeneous, resembling a pure metal in its structure. This homogeneous solid has no fixed composition, but may be produced from a range of mixtures of the two liquid metals; it is known as a solid solution. Its properties resemble roughly those of the metal which is in the greater proportion, modified to an extent depending on the amount of the second metal present.

Solid solutions are common constituents of alloys and are of great industrial importance, since they frequently possess more useful properties than either of the pure metals. For example, copper is a ductile, workable metal, but is too soft and weak for many applications; but when about 5 per cent. of tin is alloyed with it to give a solid solution (bronze) its strength and hardness are improved, whilst its workability and ductility are to a large extent retained. In a similar way tin is often hardened by adding a few per cent. of antimony.

A Valuable Guide

A recent technical publication of the International Tin Research and Development Council, " Equilibrium Diagrams of Binary Alloys of Tin," by Ernest S. Hedges, D.Sc., M.Sc., Ph.D., A.I.C., and C. E. Homer, B.Sc., Ph.D. (Tech. Pub., Series B, No. 2), contains diagrams relating to the binary alloys of tin with no less than 34 of the elements. To the research worker these diagrams are useful because they indicate which groups of alloys are likely to be capable of improvement and development. The practical man who is concerned with the preparation of alloys containing tin for specific purposes will find the diagrams a valuable guide to the attainment of the properties he desires his alloys to have. The data which is given has been taken from the original literature, and the diagrams are arranged alphabetically according to the name of the element alloyed with tin.

The solidification of a uniform liquid solution to form a uniform solid solution is a feature only of certain groups of alloys. Many behave quite differently. In a few cases, for example, the two liquid metals completely dissolve in one another only when mixed in certain proportions, other molten alloys of the system separating into two immiscible liquids; this is, however, a comparatively rare phenomenon. Of more frequent occurrence is the solidification of a uniform liquid solution to form an intermetallic compound. Such compounds are of fixed compositions, corresponding to chemical formulæ and are obtained in the pure state only when the two component metals are alloyed in the correct proportions. In themselves, intermetallic compounds are seldom of much practical value since they are usually very hard and brittle, but they may be important constituents of alloys. Sometimes a compound dissolves, or is dissolved by one or other of the pure component metals, giving solid solutions of modified properties.

Phases in Binary Alloys

A large number of binary alloys do not consist entirely of one liquid or solid solution or one compound, but contain two or three such substances. These various homogeneous, physically distinct substances which are present in an alloy are known as phases. Three phases can exist together in binary alloys only at a limited number of combinations of temperature and composition. Alloys containing two phases are, however, more numerous than any other type. In such cases the properties of the alloy as a whole vary considerably according to the nature of the phases. The different properties lead in turn to different applications. For example, alloys consisting of crystals of a hard compound embedded in a soft and tough solid solution may be useful for bearing metals, whilst an alloy in which one hard brittle compound is associated with another similar compound will find only limited application for special purposes.

Many alloys undergo structural changes of various types on heating or cooling, with consequent changes in mechanical and other properties. An alloy consisting partly of solid solution may be unworkable at room temperature owing to a large amount of a hard, brittle compound in its structure; but, on heating, the solid solution may dissolve the compound, or the two may combine to form a new solid solution. Thus, above a certain temperature there will no longer be any hard brittle crystals present, and the alloy will become workable. In other cases an alloy consisting of a uniform, ductile, solid solution at low temperatures may undergo a transformation on heating, as a result of which a brittle constituent is produced. It may thus be impossible to roll it above this temperature although it can be worked readily when cold.

Two Important Features

Apart from the structure after solidification, important features of an alloy are its melting point and manner of solidification. The melting point of an alloy may be considerably higher or lower than those of the two metals of which it is composed. Frequently alloys of both types may be produced from the same metals by varying the composition. Very few alloys have a sharp melting point, resembling that of a pure metal, but melt or solidify over a range of temperature. Throughout this range they consist partly of solid and partly of liquid and are therefore in a pasty condition. This is in some cases of practical use, as in the production of wiped joints with plumber's solder. A further important feature of this range of solidification is that the solid deposited is not of the same composition as the liquid from which it separates. This has a considerable influence on the structure of the solid alloy.

On account of the variety of properties which may be encountered in different alloys and the way in which the characteristics of any one alloy vary with temperature it is essential to have some guide to each alloy system. This is provided by the equilibrium diagram, which shows graphically the compositions at which the various solid solutions and compounds of the two metals are formed, and the temperatures at which the alloys of the system undergo changes of state or of structure. In this way it provides a guide for industrial melting and heat-treatment processes, and indicates to the research worker which groups of alloys are likely to be capable of improvement and development. The equilibrium diagram applies only to equilibrium conditions, which may not be attained completely in industrial processes, owing, for example, to rapid changes of temperature. Even when the alloys are not in equilibrium, the equilibrium diagram still provides the best possible clue to their behaviour.

Interpretation of Equilibrium Diagrams

Any point on an equilibrium diagram represents an alloy of a definite composition at a definite temperature. The composition is obtained by drawing a verticle line to cut the horizontal composition-axis of the diagram, while the temperature is obtained by drawing a horizontal line to cut the vertical temperature-axis. The different areas of the diagram show the various types of structure which are to be found in alloys of the two metals, and the range of temperature and composition within which they can exist. As an example, reference may be made to the equilibrium diagram for tin-gallium alloys. It is clear that any point above the line AEC represents an alloy in the completely molten condition, whereas a point below the line BED represents an alloy entirely solid. The line AEC is known as the liquidus of the diagram, and the line BED as the solidus. The areas ABE and ECD represent alloys in the semi-solid condition, consisting of a solid pure metal and still liquid alloy.

In order to study the behaviour of any particular alloy on heating or cooling, a vertical line is drawn through the point on the base line corresponding to its composition. Wherever this line crosses one of the lines of the diagram some change takes place in the alloy. In Fig. 1 the line FG represents an alloy containing 50 per cent. each of tin and gallium. When an alloy of this composition is cooled from the fully molten state it begins to solidify at about 116° C., crystals

of pure tin being deposited. This formation of tin crystals continues with falling temperature down to 20° C., when the remaining liquid suddenly solidifies. Below 20° C. no further

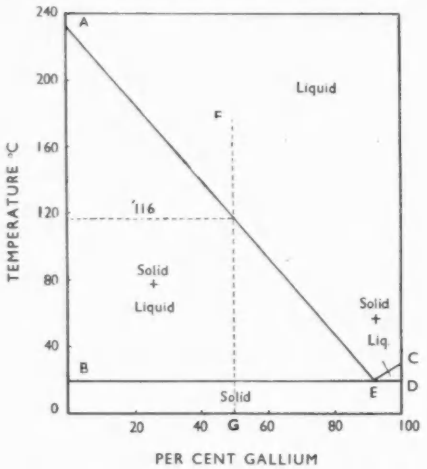


Fig. 1.—Tin-gallium diagram after N. A. Puschin, S. Stepanovic and V. Stajic.

change occurs, and the line FG crosses no more lines of the diagram.

When an alloy is heated or cooled over a range of temperature which is entirely inside one area of the diagram, no essential change occurs in its structure. Such a change occurs only when one of the boundary lines of the diagram (such as AE or BD in Fig. 1) is crossed. But if the alloy consists of two distinct constituents their compositions and relative proportions may be altered within certain limits by the change of temperature. This is the case when one of the constituents is liquid or when one or both are solid solutions,

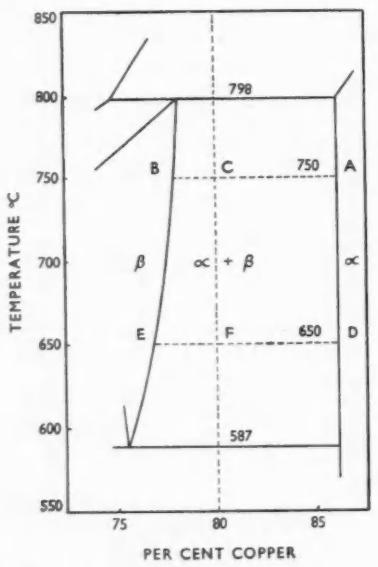


Fig. 2.—Portion of tin-copper diagram after O. Bauer and O. Vollenbruck.

since these substances can vary in composition to some extent without losing their identity or essential characteristics.

It is often useful to be able to determine the relative amounts of the two constituents present in an alloy of this kind, and their compositions at a particular temperature. There is a simple method whereby this information may be obtained from the diagram. In Fig. 2, which is a small portion of the tin-copper diagram, an alloy containing 80 per cent. of copper is shown to consist of a mixture of the two solid solutions α and β between 587° and 798° C. Suppose it is required to find the compositions and relative amounts of α and β at 750° C. A horizontal line is drawn across the diagram at this temperature, crossing the area in which α and β exist together, and cutting the boundary of the pure α field at A and that of the pure β field at B. Then the points A and B give the compositions of α and β which exist together at 750° C. in the alloy under consideration. These are seen to be about 86 and 78 per cent. of copper respectively. The compositions of α and β would be the same at 750° C. for any alloy of which the composition lay between A and B, although the amounts of these constituents would vary.

The relative proportions of α and β at 750° C. in the alloy containing 80 per cent. of copper are given by the sections into which the line AB is divided by the vertical line representing the composition of the alloy. The relation is inverse, *i.e.*, $\alpha : \beta :: BC : AC$. In the above example there is about three times as much β as α. On cooling to 650° C. the compositions of α and β would be given by D and E respectively (86 and 77 per cent. of copper) and the relative amounts by $\alpha : \beta :: EF : DF$. It is evident that on cooling from 750° to 650° C. the β constituent of the alloy becomes somewhat richer in tin, but this is accompanied by a reduction in the amount of β present. The method described can be applied to all alloys containing two constituents, whether solid or liquid.

Detergents for Tinned Ware

Additional Use of Sodium Sulphite

THE removal of tin by chemical attack from the tin linings of the steel and copper vessels used in the dairy industry occurs almost entirely during the cleaning operations. Hot solutions of sodium carbonate are largely used to remove the milk films from dairy plant, but they attack and remove the tin. Researches carried out by Mr. R. Kerr, M.Sc., Ph.D., for the International Tin Research and Development Council, and now published by the Council as Technical Publication Series A, No. 19, have shown that small amounts of sodium sulphite added to alkaline solutions cause a great reduction—actually to about one-tenth part—in the attack on tin coatings. Results of several series of experiments are given, with graphs, and it is deduced that the beneficial effect of the sulphite is due to its power to react with the oxygen dissolved in the detergent solution.

The experiments recorded were carried out with concentrations of sodium carbonate or caustic soda similar to those normally used in cleaning operations and over a range of temperature from 40° to 100° C. It is remarked that as well as being the most efficacious agent for absorbing oxygen amongst those tried, sodium sulphite is inexpensive, relatively stable in the solid state, readily soluble in water and alkaline solutions. Further, its oxidation product, sodium sulphate, has no deleterious effects.

The experiments confirm that the corrosion of tin and tinned copper in hot sodium carbonate and sodium hydroxide solutions is largely controlled by the dissolved oxygen concentration of the solution, and only to a slight extent by temperature and concentration of alkali. Recognition of this fact indicated the possibility of adding a reducing agent to the solution to provide a cleaning material which has the requisite detergent properties and a decreased tendency to attack the tin. Among various reducing agents examined sodium sulphite was found to be the most promising. This substance has the advantages of being inexpensive, relatively stable in the solid state, and readily soluble in water and alkaline solutions, whilst the product of oxidation, sodium sulphate, is unlikely to have any deleterious effect. By the addition of sodium sulphite to the alkaline solution the rate of attack of tin may readily be reduced to nearly one-tenth.

With the concentrations normally used in cleaning operations a ratio of 1 part of sodium sulphite to 10 parts of crystallised sodium carbonate is recommended. Where soda ash or caustic soda is used a ratio of 1 : 4 would be suitable, whilst for exceptional copnditions the concentration of sulphite may be increased as desired. The mechanism of the reaction appears to consist in the removal of the dissolved oxygen in the solution.

Special consideration has been given to the particular conditions which exist in the dairy industry, in which the basis metal is usually copper or steel to which tin has been applied in the molten state by wiping or dipping.

The Smelting of Chromium Metal

Details of an Abandoned Process

THE property of chromium in conferring great hardness on alloys and alloy steels was early appreciated, and soon led to the manufacture of the pure metal. The research work involved was of value to other smelting processes, but was not persevered with in respect of chromium, owing to the substitution of the cheaper ferro-chromium.

Chromium metal, however, is still used in the pure condition, and is also marketed as fused and powdered chromium, but the extent of their applications are small compared with those of the ferro alloy. Ferro-chromium is almost essentially an impure product containing appreciable percentages of carbon, and for this reason it was contended that the pure metal would eventually supersede it. At the moment, ferro-chromium is supplied in four grades containing practically the same chromium content, but associated with different carbon percentages; the poorest grade contains as much as 8 per cent. of carbon, and the highest grade less than 0.5 per cent. The difficulty of removing carbon from such a readily oxidisable metal as chromium will be appreciated, and it is for this reason that the best grade is so much more expensive, and, alternatively, has been prepared by the thermit and similar methods.

Development Abroad

These points were recognised by the makers of pure chromium, and accordingly it was hoped that producers of high-class alloy steels would prefer the pure metal. The expense of the latter, however, caused comparatively few large sales, and large-scale smelting practice had to be discontinued. With the closing of the pioneer works in Glasgow, the smelting of chromium appeared to leave this country, but has since been developed abroad.

The layout of the plant for chromium production differs materially from that of the usual smelting works, and in many respects more resembles that of a chemical manufacturer. On the other hand, ferro-chromium is prepared by directly smelting chrome-iron ore in electric furnaces, but the same means are not available for removing impurities.

In large-scale production the chrome-iron ore is first passed through the same wet extraction process as is employed in the manufacture of dichromates. The chrome-iron ore is mixed with sodium hydrate in preference to the earlier sodium carbonate, and roasted in hand-fired reverberatory hearths. Here the use of lime keeps the mass open. The products of the process are chromates of soda and a by-product from which the sodium hydrate is recovered for further use. Potassium chromate is also made and converted to dichromate by addition of sulphuric acid, whilst ammonium dichromate is also prepared by an associated process. Chromic oxide is obtained from either of these products by heating with sulphur, starch, or other addition agents, which convert the mass so that on lixiviation, pure green oxide of chromium remains as an insoluble residue.

Thermit Method of Production

Although the pure oxide of the metal is thus obtained, the difficulties of reducing this oxide to metallic condition on a large scale have been well appreciated, and hence the reason for making use of the thermit method of production. Experimental work revealed that by heating chromic oxide with carbon at 1,185° C. a powder representing pure metallic chromium could be obtained, but this was of little value for alloy production, except at the risk of high oxidation losses. Numerous patents were also taken out whereby the metal was reduced by the addition of zinc, magnesium and sodium, etc., but from an economic point of view these did not appear to be very promising.

From the results of the large-scale smelting process, it would appear that, irrespective of how additions of carbon are made, following the reduction of nickel cubes, this element will almost invariably remain present to the detriment of the final product. Most of the earlier workers made a practice of pressing the chromic oxide and other constituents into the form of cakes under great pressure with the assistance of some binding material. From a practical standpoint this was partially erroneous, as what metallic reducing agents were included were not thus given the same opportunity to react except at the expense of the pressed cake. As the process progressed the cakes tended to break down into powder and the loose mass increased the difficulties of reduction.

A smelting furnace was evolved to meet the requirements of chromic oxide reduction, and at the time was regarded as the best high-temperature hearth in the country. This was before electric furnaces came into prominence, but it is recognised that many of the latter would not suit the conditions of preventing an excess of carbon being absorbed by the hot metallic product.

One of the features of the work is to prepare a perfectly pure metal as distinct from the much cruder ferro-chromiums which are used. After much research work was carried out it was realised that even the addition of the theoretically calculated proportion of carbon would not suffice to prevent carbon from being absorbed. That is, the carbon reduced the chromic oxide to metallic chromium, and tended to leave part of the reaction incomplete, and hence the reason for the product containing a certain amount of this impurity. When it is remembered that even under the best ordinary reducing conditions there is always the risk of a highly oxidisable metal such as chromium being influenced by the furnace gases, this fact is the more surprising. Ultimately, better results were secured by deliberately using a proportion of carbon less than that theoretically required, but at that time this system of working was abandoned. Great advantage was taken later when devising a hearth to smelt the chromium on a large scale to ingot form. This furnace was constructed so as to ensure the most perfect reducing conditions, and also attain the necessary high temperature.

High Temperature Necessary

Although the melting point of chromium is placed at approximately 1,500° C., this only represents the degree at which it has reached a soft and pasty condition, and a much greater temperature is necessary before such metal can be successfully tapped. The furnace has therefore to be capable of maintaining the reducing conditions at temperatures similar to those obtaining in blast-furnaces for iron. Construction of the furnace used in Glasgow resembled a blast-furnace in outward appearance, but had channels and flues which allowed the hot gases to escape without impinging in any way on the hot mass. It was really a form of muffle furnace, and the chrome oxide was mixed with a minimum of carbon and caused to lie in close proximity to a specially selected carbonaceous lime bed.

It usually requires several hundred degrees of heat above the stated melting point to bring chromium to a satisfactory condition for tapping. The tapping operation is not done in the open, but in a small adjoining hearth which is kept heated by an independent fire, and cut lime blocks are used to receive the molten product. In this manner the chromium flows from the tap hole to the lime ingot blocks protected above by a layer of unreduced chromic oxide, etc., and below by material which contains a proportion of carbon. Anything in the nature of free carbon was found to be useless for this purpose, and when more richly carbonaceous clay-lime blocks were substituted they proved to be unsatisfactory. Carbon appreciably lowers the melting point of chromium, and advantage had long been taken of this feature to prepare the more crude product. In the foregoing case the high-temperature furnace was able to superheat the chromium and thus render it sufficiently fluid for tapping purposes.

THE production of metallic cadmium in the United States in 1934 amounted to 2,777, 384 lb., an increase of 22 per cent. as compared with 1933. In addition to metallic cadmium, manufacturers reported the production of cadmium sulphide, oxide, lithopone, selenide, hyrdate, sulphate and carbonate. These compounds required 566,700 lb., an increase of 41 per cent. when compared with 1933. The production of electrolytic cadmium at the Electrolytic Zinc Co.'s plant, Risdon (Tasmania), is 200-250 tons annually. The metal is recovered from zinc dust precipitate, an intermediate product in the purification of the zinc sulphate solutions.

Some Recent Metallurgical Patents

Treating Metallic Surfaces

A COMPOSITION for treating metal surfaces to form a protective film by reaction with the surface consists of aqueous orthophosphoric acid containing a small proportion of a sulphonated animal or vegetable oil, such as sulphonated castor, corn, cotton seed, olive or fish oil, or of an ether, such as isopropyl ether, dipropyl ether, butyl ether, ethyl propyl ether or ethylene glycol monoethyl ether. The substances may be emulsified together or dissolved with the aid of solvents such as ethyl or methyl alcohol or acetone. (See Specification No. 428,381, of Grasselli Chemical Co. and W. K. Schweitzer.)

Coating Metals with Metals

METALS are protected against oxidation at high temperatures by first applying a layer of nickel by hot rolling and then applying aluminium, for example by dipping or spraying. In an example, iron or steel is coated with a layer of nickel 0.008 inches in thickness by rolling at about 800°C. Aluminium is then sprayed on to a thickness of 0.002 inches. The coated article is then heated to about 1,000°C. to form a nickel-aluminium alloy at the surface. The special heat-treatment may be omitted when the articles attain the alloying temperature in use. (See Specification No. 428,855, of H. W. Brownsdon and Imperial Chemical Industries, Ltd.)

Preventing Adhesion of Metals

TO prevent adhesion of molten metal to rolls they may be made of aluminium bronze containing up to 12 per cent of aluminium, or of silicon gronze containing up to 8 per cent of silicon, or of iron containing up to 10 per cent silicon, or of other metal containing a sufficiently high percentage of aluminium or silicon. If the melt contains a sufficient percentage of aluminium or silicon the rolls may be made of cast iron, steel, copper, bronze, brass or similar material. (See Specification No. 429,005, of Finspongs Metallverks Aktiebolag.)

"Hard Metals"

HIGHLY plastic organic tungsten compounds are obtained by reacting ammonium tungstate with gallic acid in such proportions by weight that the ratio of gallic acid to ammonium tungstate is between 1:2 and 4:1. The reaction is effected in the presence of a mineral acid, and the ammonium tungstate may be replaced by alkali metal tungstate. "Hard metals" may be produced by mixing the reaction product with a finely divided refractory metal such as tungsten together with carbon, or with tungsten carbide, and with a metal of lower melting point such as cobalt, and sintering the mixture in known manner. (See Specification No. 428,627, of A. Pacz.)

Sodium Carbonate in the Foundry

Refining Cast Iron and Non-Ferrous Metals

SODIUM carbonate for the refining of cast iron and non-ferrous metals will be shown by Imperial Chemical Industries, Ltd., at the Foundry Trades Exhibition, to be opened in London on September 12 in conjunction with the Shipping, Engineering and Machinery Exhibition. There will be displayed granular sodium carbonate and fused sodium carbonate blocks; the plant used in the process; and samples of ferrous and non-ferrous castings already treated.

The sodium carbonate process consists of the treatment of metals with a highly reactive slag which has a refining, degasifying action, and removes sulphur, oxides, silicates, etc. Castings so treated are sounder and free from porosity and have better machining properties, while for those required to withstand hydraulic pressure the treatment is specially useful. The reduction of the sulphur content is of particular value in connection with steel making, and with sodium carbonate it is frequently possible to use a cheaper mixture in the cupola.

A Specially Designed Ladle

Recent progress in this application of sodium carbonate has revealed the need for special plant, and the central exhibit on the I.C.I. stand will be a specially designed teapot ladle which facilitates the separation of slag from metal and thus increases the efficiency and speed of the process. This type of ladle can be used either as a receiver or for direct castings, and plant layouts will be illustrated. For use in the ladle the granular form of sodium carbonate is provided. It is a dust-free product of a high degree of purity and is widely used in the treatment of blast furnace and mixer metal, and of iron castings of all descriptions where low sulphur content, clean metal, freedom from porosity and blowholes, and uniform machineability are required.

For other foundry uses fused blocks of sodium carbonate, weighing 4 lb., are employed. This is suitable for addition to the cupola charge, or for the treatment of non-ferrous metals when it is required to plunge the flux below the surface of the melt by means of a perforated bell. Its use makes the slag more fluid and keeps the furnace lining clean so that repair costs are reduced to a minimum. Sodium carbonate is also used as a flux in the melting of brass and bronze swarf, where it prevents loss of zinc by volatilisation and removes entrained oxides and other non-metallic inclusions; in the modification of aluminium silicon alloys; and in connection with the basic open hearth, acid and basic Bessemer, and Tropenas processes.

Iron and Steel Institute

Autumn Meeting at Manchester

THE autumn meeting of the Iron and Steel Institute will be held in Manchester from Monday to Thursday, September 16 to 19.

A reception committee, representing the iron, steel and engineering industries of Manchester and Lancashire, has been formed. The Earl of Crawford and Balcarres is the president of this committee; Mr. J. E. James, chairman; Alderman F. J. West, hon. treasurer; and Mr. H. D. Lloyd, hon. secretary. The committee includes representatives of works on the Cumberland coast to which invitations to pay visits have been received.

Papers to be presented at the meeting include:—"Sixth Report on the Heterogeneity of Steel Ingots," being a report by a joint committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council. (Special Report No. 9.) "Waste-heat Boilers in Open-Hearth Practice." Second report of the Open-Hearth Committee, being a committee of the Iron and Steel Industrial Research Council. (Special Report No. 10.) E. W. Fell: "The Piobert Effect in Iron and Soft Steel." E. T. Gill and R. Goodacre: "Some Aspects of the Fatigue Properties of Patented Steel Wire. II.—Note on the Effect of Low-Temperature Heat Treatment." W. E. Goodrich: "The Penetration of Molten White Metals into Stressed Steels." R. H. Greaves: "The Properties of Some Low-Nickel Steels containing Manganese." R. Griffiths: "Subcutaneous Effects during the Scaling of Steel." A. M. Herbert and F. C. Thompson: "The Use of the Hele-Shaw Apparatus in the Investigation of the Flow of Metals." W. E. Hoare and B. Chalmers: "Examination of the Surface of Tinplate by an Optical Method." C. H. M. Jenkins: "Behaviour of Mild Steel under Prolonged Stress at 300° C. Part II.—Experiments on Concentrated Stress in Notched and Drilled Specimens." C. H. M. Jenkins and G. A. Mellor: "Investigation of the Behaviour of Metals under Deformation at High Temperature. Part I.—Structural Changes in Mild Steel and Commercial Iron during Creep." E. Maurer and W. Bischof: "The Distribution of Phosphorus between Metal and Slag in the Basic Process of Steel Manufacture." A. M. Portevin and R. Castro: "The Morphology of Inclusions in Siderurgical Products."

The sessions will be held at the Manchester College of Technology; the meeting on Tuesday, September 17, will take place in the Grand Hall, starting at 9.30 a.m., and that on Wednesday, September 18, in the Students' Common Room, commencing at 9 a.m.

Metallurgical Section

October 5, 1935

Refractories for Electric Furnaces

RECENT developments in refractories and their applications have done much to increase the economic value of the electric furnace for producing high test cast iron, high strength cast iron and alloy iron generally. According to Mr. L. C. Hewitt ("Transactions of the American Foundrymen's Association," August, 1935) the refractory problem is greater for the indirect arc furnace, and with the possible exception of the direct arc roof, different types of refractories are required. The introduction of a comparatively new type of refractory classified as super fire-clay brick has greatly aided in reducing refractory costs for the indirect arc furnaces and should find application as a roof material for the direct arc furnace. This refractory is noted for its combination of low porosity and high thermal shock resistance, together with high refractoriness and volume stability at high temperatures. Careful lining, with a minimum number of joints, the use of proper bonding cement, precautions during the preliminary heating period, a close control over superheating temperature, and the use of barium compounds as a metal cleanser and lining conditioner, are among the service factors which Mr. Hewitt cites as bearing upon the refractory performance. The superheating temperature and its duration exerts the greatest influence upon lining life. As soon as the fusion temperature of the refractory is reached, rapid deterioration proceeds. Metal temperature readings are lower than those of the furnace wall, and this should be taken into consideration in determining the superheat limit. An increase of 100° F., as a bath temperature of 2,900° F. is reached, will greatly limit the refractory life. Introduction of the charge and the closing of the furnace at the end of the day's operations aids in preventing a rapid cooling of the lining, and also serves to conserve a considerable amount of heat that would otherwise be lost during the night.

Metal Melting

NO particularly new ideas were brought to light in Dr. Brownsdon's Autumn Lecture to the Institute of Metal at Newcastle last month, but Dr. Brownsdon certainly arranged the known facts in an orderly fashion and focussed the attention of his audience on several important points, one being the influence of gaseous constituents on the properties of metals in the cast state and also after subsequent working. He pointed out that the usual analysis of a metal gave no indication of gaseous constituents, and that, although a purity of 99.999 per cent. might be as near virginity as ever required where metallic impurities are concerned, the remaining 0.001 per cent. of gaseous impurities could exert some influence on the quality of the metal. Problems associated with gases in metals—free, combined or reaction—are difficult problems, but through the medium of the spectroscope it is anticipated that their secrets will be ultimately revealed. The main point brought out in the discussion, which followed Dr. Brownsdon's lecture, was that some of the worst troubles are caused by water vapour, which dissociates into oxygen (giving oxides of the metals) and into nascent hydrogen (which is absorbed). In vacuum melting, of course, there is no water vapour, but it has been stated that completely gas-free metals are difficult to cast into intricate shapes.

Vacuum Refining for Metals

DISCUSSING the refining of chromium, aluminium, silicon, beryllium and iron by evaporation in high vacuum, Dr. W. Kroll ("Metal Industry," July, 1935) states that at extremely low pressures there is no "boiling" phenomena, but only "evaporation" from the liquid or solid metal surface. Gaseous metals, moreover, are completely transparent, and the body of metal can be observed throughout the operation. Distillation, even in a good vacuum, however, presents considerable difficulties, particularly in the case of aluminium, which contains much gas escaping slowly during the whole evaporation process. In order to ascertain how the impurities of commercial aluminium behave on distilling, Dr. Kroll prepared a synthetic melt and collected two successive distillates for analysis. The results of this investigation show that silicon, iron and copper remain mostly in the residue, although small traces could be found in both distillates. The whole of the titanium, however, remained in the residue, and whilst manganese was completely separated, most of it concentrated in the first distillate with only traces remaining with residue. Beryllia as a crucible material resists the action of the molten aluminium perfectly, boiling metal—after a period of one hour—extracting only 0.09 per cent. of beryllium.

Sodium Metal in Bulk

AT a recent meeting of the American Institute of Chemical Engineers, Mr. P. J. Carlisle described the handling of sodium on an industrial scale. This highly reactive metal is now available in cast bricks weighing from 1 to 12 or 24 lb.; for most industrial purposes the 12 and 24 lb. bricks may be fed directly into the reaction system. A comparatively recent development is the shipment of solid sodium in tank cars, of 80,000 lb. capacity, which may be filled in 16 hours and melted and unloaded in 13 hours. These cars have steel coils welded on the outside surface, through which cold oil is circulated during the filling and hot oil while unloading. In filling, the air is displaced with nitrogen prior to admitting the sodium. Large quantities of sodium may also be conveyed from one point to another by melting the metal and conducting it through a pipe-line.

In one installation in the United States sodium has been transported for over two years through a $2\frac{1}{2}$ in. welded iron pipe about 1,200 ft. long. The heating of this pipe is done by means of an electrical resistance, consisting of a welded $\frac{1}{2}$-in. steel pipe mounted parallel to the pipe-line and insulated from it. Sodium is caused to flow through the pipe-line by applying a partial vacuum to the outlet end, and on some occasions this flow has been as great as 20,000 lb. per hour.

A Substitute for Tinplate

THE process for coating steel with aluminium, discovered in the United States by Dr. Colin G. Fink, is being tried out on a commercial scale as a substitute for tinplate used in food canning. The product is claimed to be highly resistent to corrosion, not only at ordinary temperatures, but also at high temperatures, and to withstand fruit and vegetable acids perfectly. Its outstanding feature is the alloy bond between the outer aluminium and the steel. Joints can be made without the use of lead-bearing solders, and so, apparently, the last barriers to its use in the food preserving industry have been removed. It is said to be in every respect equal in utility to tinplate and to be actually cheaper. According to a recent issue of the "Deutsche Bergwerks Zeitung," the Norwegian fish-canning industry used 10,000,000 rolled aluminium containers in 1934, compared with 2,000,000 in 1933. Germany is strongly interested in this development, inasmuch as Germany produced 32,700 tons of aluminium in 1929 and by the end of 1935 will have a producing capacity of 71,000 tons. Aluminium production may be considered purely a German industry, whereas tin has to be imported.

Metal Crystallisation under Vibration

IN some published accounts of a recent endurance aeroplane flight, publicity was given to the belief that metals may fail as a result of crystallisation caused by vibration in service. This erroneous belief, however, seems to have originated in an incorrect conclusion drawn from the typical appearance of the fractured surfaces of metals that failed after having been subjected to repeated cycles of service stresses. All metals in the solid state are aggregates of crystalline grains, generally of microscopic size. It is also known that the original crystalline structure cannot be altered by purely mechanical forces which do not permanently alter the outward form of the metal piece. When a metal breaks from a single application of a force, the fracture takes place along natural cleavage planes through the crystal grains and the fracture exhibits a characteristic crystalline appearance. In ductile metals, however, fracture does not take place until considerable deformation has occurred, but when metals are subjected to repeated applications of force, fracture can occur without deformation (even in the most ductile metals) if the range or amplitude of the force exceeds a limiting value. For steels this endurance or fatigue limit is generally about 50 per cent. of its strength under steady loads, but can be as low as 20 per cent. or as high as 60 per cent.

Fracture originates at a point where the stress is the maximum, or in some localised weakness; the crack itself, once started, is a localised weakness and grows with repeated stress application, generally perpendicularly to the direction of the applied forces. As the advancing crack cuts off more and more of the sound metal, the load is carried by a progressively decreasing area, and finally a sudden and complete rupture occurs. This combination of the sudden break with the formation of a fracture which one is accustomed to find in very brittle materials is disconcerting, and it could be rather natural to conclude, from the observation of such a fracture, that a portion of the metal had "crystallised" and therefore become brittle and failed unexpectedly. Such a conclusion, however, is contrary to the known facts.

Precious Metals for Chemical Plant

THE use of platinum in chemical equipment need not be confined to very small parts; it is quite feasible to make large vessels, tubing, etc., of this metal. The initial cost is naturally higher than if base metal alloys are used, but it should not be overlooked that the resale or scrap value of platinum is very high. Practically any shape can be fabricated, any necessary repairs can be easily made, and, as stressed by chemical engineers at a recent meeting at Wilmington in the United States, there is the assurance that the vessel will have a long and healthy life. Large amounts of gold and even greater quantities of both pure silver and sterling silver are being used in the manufacture and equipment for the production of heavy chemicals, on account of their special physical properties. Gold has a fairly high melting point and does not oxidise at any temperature. The use of the pure metal may sometimes be necessary, but it has the disadvantage that it is quite a soft material and is easily distorted. In order to increase its resistance to distortion it is necessary to alloy the gold with other materials. The addition of platinum metals to the gold is rather obvious since these rapidly increase the hardness and rather increase the resistance of chemical attack.

"Free-Cutting" Aluminium Alloys

SO-CALLED "free-cutting alloys" of aluminium have recently been patented in the United States. A considerable amount of research has been carried out in order to attain this need of the light metal engineering industry. It was the success of lead brass rod for screw machines which primarily caused the aluminium research workers to investigate methods for the alloying of metallic lead and aluminium. The resulting new alloys, with sufficient amounts of lead present, were found to be "free-cutting," but the concentration of lead required for satisfactory machineability in the commonly-used strong aluminium alloys was too high for the practical production of ingots which were uniform in chemical composition. According to the "American Metal Market," July 10, 1935, even small ingots of fairly uniform composition were difficult to work in the hot condition. The difficulties were ultimately overcome by the discovery that the simultaneous presence of small concentrations of a multiplicity of elements was much more efficient in producing satisfactory machineability than one element alone. Lead and bismuth were chosen because it was further found that these two elements had relatively small effect on the other properties of the alloy. In order to induce ageing at room temperature, magnesium was added to the aluminium-copper-lead-bismuth alloy, but this addition was found to impair the free-cutting properties.

Recent Progress in Non-Ferrous Metals Research

Annual Autumn Meeting of the Institute of Metals

THE 27th annual autumn meeting of the Institute of Metals was held in Newcastle-upon-Tyne, September 9-12, by kind invitation of the North-East Coast Local Section, under the chairmanship of the President, Dr. Harold Moore.

The proceedings began on Monday evening, September 9, when the fourteenth autumn lecture on "Metal Melting—Its Effect on Quality" was delivered by Dr. H. W. Brownsdon, M.Sc., in the King's Hall, Armstrong College. Dr. Brownsdon defined his idea of "quality" not in terms of specifications, but on much broader lines, namely, that a metal of high quality is that which meets the needs of the user to the fullest extent, making it clear that in one and the same metal or alloy very small changes in composition may render it suitable for one application and unsuitable for some other. From a metal melting point of view this control of quality became in effect a control of composition and that it is in this accurate control of composition that difficulties associated with metal melting arise. He then reviewed the numerous factors influencing the composition, dividing these up under the headings of raw materials, contamination arising during melting, removal of undesirable constituents during melting and finally some other factors bearing on quality.

Dr. Brownsdon's Autumn Lecture

Dr. Brownsdon drew a simile between what the metallurgist has to do for the prevention and removal of undesirable constituents in molten metal with the part played by the surgeon in the curing of human ills, and referred to the melting pot as the operating table of the metallurgist, pointing out the many difficulties that the metallurgist is met with in the satisfactory carrying out of melting operations. It was shown that in metal melting it is the little things that matter and that in spite of all the scientific investigational work that has been done on molten metals, some of their secrets still remain unrevealed. He then dealt with methods adopted for the removal of undesirable impurities, again stressing the difficulty of obtaining the desired object; under this heading such subjects as the use of deoxidising agents and fluxes, treatment with gases, and vacuum melting came under review. Special reference was also made to another important aspect of metal melting, *viz.*, the difficult operation of freeing the melted metal from gases.

After the lecture the meeting was thrown open to discussion and the more important points elaborated by members who, as a result of experimental or practical experience, could speak with authority on special "quality factors."

To members of the Institute, Dr. Brownsdon is well-known as a member of the Council and a frequent contributor to the pages of the Institute's Journal, and his lecture is typical of his wide outlook on metallurgical problems. As research manager to the Metal Group of Imperial Chemical Industries, Ltd., he has not only opportunity for carrying out experimental work, but is also in the happy position of being able to follow up the results of such work by applying them to the solution of production problems. His interest in the application of science to industry finds full expression in the active support which he gives to the British Non-Ferrous Metals Research Association. From his Autumn Lecture it is not difficult to see that his outlook on metallurgical problems is influenced by his earlier training as a chemist and he is a strong advocate of the view that present-day students in metallurgy would profit considerably if they had a fuller and more general chemical training, as a foundation on which to base their metallurgical work.

The Institute's President

Dr. Harold Moore, who is now serving his second year as president of the Institute of Metals, is not unconnected with the North East Coast, having been born in Middlesbrough in 1878. His metallurgical training started under the late Dr. J. E. Stead, F.R.S., with whom he worked for five years as pupil and later as assistant. Dr. Moore then entered industry for a time, becoming chemist to the Islip Iron Co., Northamptonshire, and subsequently head of the research department of Wm. Beardmore and Co., Glasgow. In 1904 he joined the staff of the Research Department, Woolwich, as chief metallurgist, later becoming director of metallurgical research in that Department, which post he held until 1932. During this period the metallurgical branch grew under Dr. Moore's guidance to an important metallurgical research centre with an international reputation. In his present post as director of the British Non-Ferrous Metals Research Association he has become still more closely linked with the particular interests with which the Institute of Metals is concerned.

Observations on Metal Losses

A paper by Maurice Cook, M.Sc., Ph.D. (I.C.I. Metals, Ltd., Witton, Birmingham), presented a study of the metal losses which occur when such alloys as gilding metals, brasses and cupro-nickel are melted in crucibles in coke-fired pit furnaces, figures being obtained from carefully controlled trials and from production runs, involving the melting of considerable quantities of material under different conditions. Observations were also made on the metal losses occurring in melting brasses of different compositions under various conditions of fluxing in Ajax-Wyatt induction furnaces, and large-scale trials covering considerable periods and involving large tonnages of metal have been made. This loss is largely due to oxidation and the results of various methods of reducing the loss were discussed.

Observations of the Porosity and Segregation of Two Bronze Ingots was the subject of a paper by N. P. Allen, M.Met., D.Sc., and S. M. Puddephat, B.Sc. (both of the University of Birmingham). The authors pointed out that the distribution of porosity and the variation in copper content in two 10 per cent. tin-bronze ingots now influenced principally by the flow of heat during solidification. There was a close connection between the porosity and segregation.

Properties of Some Special Bronzes

Discussing the properties of some special bronzes obtained by additions of aluminium, manganese, aluminium plus manganese, iron and silicon to copper-tin bronzes, Professor D. Hanson, D.Sc., and M. A. Wheeler (both of the University of Birmingham) said that so far as aluminium is concerned within the range of compositions investigated alloys consisting of one solid solution work readily, either hot or cold. Alloys possessing a duplex structure, however, can be worked with much greater difficulty, and are specially difficult in hot-working. The range of compositions in which easy working properties can be obtained can be extended by annealing duplex alloys to give a homogeneous structure. Alloys containing 2 per cent. or more aluminium are fairly resistant to oxidation at high temperatures, particularly if the cast surface is not damaged. Polished alloys have a pleasing appearance, and are fairly resistant to tarnishing in the air, but the scale formed when the alloys are heated is very difficult to remove, either mechanically or by pickling processes.

Manganese has a relatively small influence on the working properties of a 5 per cent. tin bronze; as much as 6 per cent. must be added before an appreciable embrittling effect is apparent, but alloys within the range of composition investigated can be worked hot or cold. Manganese, however, increases the softening temperature of the tin bronzes. Copper-tin bronzes containing both aluminium and manganese, within the range investigated, are difficult to cold-work, without annealing, if the aluminium content exceeds about 0.25 per cent. With aluminium contents up to about 3 per cent. they may be cold-worked if they are previously rendered homogeneous in structure by annealing. Aluminium increases the tensile strength of manganese-tin bronzes, without appreciably reducing the ductility.

Iron, in the form of American washed iron, alloys readily with copper, and 4 per cent. of iron can be incorporated without difficulty. Iron-tin-copper alloys containing 5 per cent. of tin and up to 4 per cent. of iron can be rolled, and the ductility decreases only slightly even when 3 or 4 per cent. of iron is present. Iron up to 1.5 per cent. has little effect on the tensile properties of a 5 per cent. tin bronze, but 2 per cent. or more of iron increases the tensile strength at the expense of the ductility. The iron is distributed uniformly

throughout the solid alloy in the form of small particles, the structures being very similar to those of iron-copper alloys containing no tin. Used to the extent of 4 per cent. iron greatly refines the cast structure of a 5 per cent. tin bronze.

Silicon has a marked effect on the cold-working properties of a 5 per cent. tin bronze. An alloy containing 3 per cent. of silicon can be cold-worked only with great difficulty in the "as cast" fondition; after annealing at 800° C. for 4 hours the cold-working properties are slightly increased The addition of 4 per cent. of silicon to a 5 per cent. tin bronze renders the material unworkable both hot and cold. The addition of silicon greatly increases the strength of a tin bronze.

An X-ray investigation of certain copper-tin alloys was reported by Professor E. A. Owen, D.Sc., and John Iball, Ph.D. (both of the University College of North Wales, Bangor).

Age Hardening of Nickel-Silicon-Copper Alloys

In their joint paper on "The Inter-Relation of Age-Hardening and Creep Performance. Part I.—The Age-Hardening of Nickel-Silicon Copper Alloys," C. H. M. Jenkins, D.Sc., A.R.S.M., and E. H. Bucknall, M.Sc. (both of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, Teddington), a report was given of an investigation on the age-hardening of nickel-silicon-copper alloys containing 3 and 5 per cent. nickel + silicon in the atomic ratio 2 Ni:1 Si. This work, which was carried out as a preliminary to the study of the inter-relation of the age-hardening of this material and its creep performance, has provided sufficient information to serve as a basis for the creep test programme and to assist in the interpretation of the creep results. The alloy containing 3 per cent. nickel + silicon when quenched from 900° C. undergoes age-hardening at temperatures of 300°-750° C. The maximum hardness is attained progressively more rapidly the higher the ageing temperature, being reached, for example, in more than 64 days at 400° C. and in less than 1 minute at 700° C. The maximum hardness is greater the lower the ageing temperature, and the attainment of maximum hardness is generally followed by softening.

Consideration was also given to points relating to the age-hardening of nickel-silicon-copper alloys and their comparison with information in the literature relating to other age-hardenable alloys, particular attention being directed to the importance of the relationship between temperature and time of attainment of maximum hardness, which is shown to be of general application.

A note on the effect of interrupted straining on the elongation of lead was presented by J. C. Chaston, B.Sc., A.R.S.M. (Standard Telephones and Cables, Ltd., North Woolwich), who found that by interrupting a tensile test on commercially pure lead at intervals, during which the specimen is allowed to rest for a short time free from stress, abnormally high values of elongation are produced. These elongation values may be as much as five times those obtained in a normal tensile test. The influence on the elongation of the duration of the rest period, the rate of straining, the amount of elongation between successive rest periods, and the grain-size were studied by tests on extruded cable-sheath samples. Abnormal elongations are not produced by interrupted straining on "hardened" lead alloys at room temperature, but it is suggested that such effects may be obtained in these and other metals and alloys if they are tested above their recrystallisation temperatures. The observations recorded may thus have a bearing in connection with high-temperature metallurgical research.

Corrosion Below Oxide Films

Corrosion below discontinuous oxide coatings, with special reference to magnesium, was the subject of a joint paper by K. G. Lewis, M.Sc. and U. R. Evans, Sc.D. (both of The University Chemical Laboratories, Cambridge). Protective processes, it was pointed out, fall into two classes: safe processes (where even incomplete treatment lengthens the time of perforation), and dangerous processes (where inadequate treatment intensifies attack and brings quicker perforation than no treatment). Magnesium, uncoated and coated with oxide layers produced by three different treatments applied for numerous different periods, was subjected to sodium chloride in a new circulating apparatus, and time-corrosion curves and perforation periods have been obtained showing that these processes belong to the "safe" class.

In their paper on the protection of magnesium alloys against corrosion, H. Sutton, M.Sc., and L. F. Le Brocq, B.Sc. (both of the Royal Aircraft Establishment, South Farnborough), reported short-time chromate treatments of magnesium-rich alloys of two type in common use, the protective value of the treatments being compared with the 6-hr. chromate and other forms of protective treatment. The protective value of the 6-hr. and short-time chromate treatments, with and without supplementary coatings of varnishes and enamels, was investigated with reference to typical alloys. Intermittent sea-water spray laboratory tests and beach exposure tests were also carried out, and the corrosion which occurred was observed by loss of weight and change in mechanical properties.

Powdered Alloys

The electron diffraction examination of protective films deposited on magnesium and magnesium alloys by the R.A.E. dichromate process was reported by H. G. Hopkins, A.R.C.S., B.Sc. (Royal College of Science, London), who said the protective films, in general, yielded diffuse diffraction rings. It is concluded that the films consist of very small crystals orientated at random, and it is tentatively suggested that the diffracting lattice is pseudo-morphic magnesium oxide.

X-ray studies of copper-silver alloys were the subject of a paper by Professor E. A. Owen, D.Sc., and Joseph Rogers, Ph.D. (both of the University College of North Wales, Bangor). Another paper by Professor E. A. Owen, D.Sc., and I. G. Edmunds, M.Sc. (both of the University of North Wales, Bangor), dealt with the determination of certain phase boundaries in the silver-zinc thermal diagram by X-ray analysis.

The production of powdered alloys of low melting point was discussed by R. W. Rees, B.Sc. (General Electric Co., Ltd., Wembley), who described a method for producing lead-base alloys in the form of powder by taking advantage of the pasty stage through which the alloys pass during solidification.

A note on the tarnishing of liquid metals by Hugh O'Neill, D.Sc., M.Met. (L.M.S. Research Laboratory, Derby), and G. S. Farnham, Ph.D. (Ontario Research Council, Toronto), described apparatus which has been constructed for the X-ray study of liquid metals up to 700° C. by surface reflection.

Forthcoming Meetings of the Institute

A FULL programme for the 1935-36 session has been planned by the Institute of Metals and its several local sections. Issued in the form of a folder convenient in size for the waistcoat pocket, this programme includes a separate page devoted to the activities of each section. These branches exist in all the principal non-ferrous metallurgical centres throughout the British Isles. Though not a section of the Institute of Metals, the Manchester Metallurgical Society is in association with the Institute and its programme, for the first time, is included in the folder, since members of the Institute of Metals are now eligible to attend meetings of the Manchester Metallurgical Society as well as of the various local sections.

The meetings of the parent body—the Institute of Metals—are to be three in number for 1936. The 28th annual general meeting (followed by the annual dinner and dance) will be held in London on March 11 and 12. The 26th annual May Lecture is to be given in the Hall of the Institution of Mechanical Engineers, on May 6. In September, Paris will be the scene of the 28th annual Autumn Meeting. This will be the first occasion on which the Institute of Metals has held a meeting in France, though most other European countries have been visited since the Institute's foundation in 1908.

The programmes of each of the local sections—which include more than 40 papers and several visits to works—are designed primarily to appeal to persons interested in local industries. In Glasgow, a paper will be read on "Corrosion of Metals by Industrial Waters"; Sheffield will be informed with regard to "Rolled Gold and its Industrial Application" and "The Adhesion of Electro-deposited Nickel." Birmingham is naturally interested in such subjects as "The Production and Control of Bronze Castings" and "The Hot Rolling of Sheets." London is fortunate in having secured Professor E. N. da C. Andrade to lecture on "The Ultimate Strength of Metals," whilst Mr. G. S. W. Marlow is to present to this section a paper on "Patent Law, with Special Reference to Non-Ferrous Metals."

Subcutaneous Effects During the Scaling of Steel

An Explanation of the Formation of Globules and Spots

MODERN requirements of surface finish on steel products have necessitated the closest attention being paid to causes of minor defects. This applies particularly in the tinplate industry, where the need for economy has resulted in the thickness of the tin coating being cut down to the minimum commensurate with adequate protection. In this and other fields, minor subcutaneous changes in the structure and composition of the articles during heat treatment may be reflected in the properties of the finished products—in particular, a decreased resistance to fatigue and corrosion may result.

In a paper read at the Autumn Meeting of the Iron and Steel Institute, held in Manchester, September 16-19, Mr R. Griffiths, M.Sc., of University College, Swansea, advanced an explanation of the formation of globules and spots below the steel surface when oxidising under certain conditions. This present paper dealt with subcutaneous changes which have been observed during the oxidation of various steels in the laboratory, but which may prove of industrial interest.

Slow Oxidation at Definite Temperatures

Many iron and steel samples, widely differing in composition, were treated and examined during the investigation. Briefly, the experiments consisted of subjecting the steels to slow oxidation at certain temperatures for periods ranging from one hour to three weeks. Holes, 3/16 in. in diam., were drilled in the specimens, which were in the form of cylinders 1 in. diam. by 1 in. long. Finely-ground scale, obtained by the oxidation of electrolytic iron, was rammed into the cavity and then sealed by means of a tightly-fitting screw plug. Using an electrically-heated silica- tube furnace, different specimens were then subjected to three conditions of heating at the various temperatures for the various times. Under the first condition, the specimens were heated *in vacuo* In the second series, slow oxidation of the exterior of the specimens was allowed in a limited supply of air, and in the final series, to produce a carburising effect, the specimens were heated in coal gas. Each specimen was then sectioned transversely through the rod to give a section with the oxide-filled cavity at the centre, the specimens being mounted to preserve the exterior surfaces, for which sealing-wax, low melting-point alloy or bakelite was used.

In the series heated at a temperature of 950° C. *in vacuo* for three weeks it was found that in the Armco iron, carbon, aluminium, manganese and chromium steels, greyish-black globules or areas were present near the metal-scale interface, together with finer spots which extended into the steel. All the steels which contained carbon previous to the experiments were found to be decarburised completely as a result of the heating for three weeks *in vacuo*. No change was observable in the appearance of the outer surface of the specimens, from the point of view of the formation of globules and spots.

Examination of Metal-Scale Interface

Turning to the series exposed to a slowly oxidising atmosphere for seven days at 925° C. it was found that the size of the individual globules was larger, but the thickness of the affected area of the steel was somewhat less at the outer scale-steel interface than at the scale-filled cavity surface. As in the series heated *in vacuo*, the appearance of the globules and spots in the various steels differed considerably. During the seven days' heating, decarburisation had taken place to a limited extent in those steels containing carbon.

With the carbon steel, when it was heated for ten days at 950° C., it was found that an inner ring of ferrite free from particles was formed in the scale-filled cavity, due probably to the reduction of the iron oxide in the cavity. The steel in the vicinity of the cavity contained globules and spots as in the previous cases. Remelted electrolytic iron revealed affected areas to a small extent, and even an iron containing 0.02 per cent. of nickel only as impurity showed distinct globules after immersion in scale and heating for 12 hr. at 950° C.

In the case of the steels heated in a carburising atmosphere for fifteen days, the globules and spots were present in the vicinity of the oxide-filled cavity as in the previous cases, but to a somewhat smaller extent than in the air-oxidised series. Carburisation of the steels had, of course, taken place, but, in addition, some of the scale in the cavity had been reduced to iron and become carburised. It was difficult to find the line of demarcation between the original wall of the scale-filled cavity and the steel.

These experiments show that by heating steels, which contain certain elements, in contact with scale, globules and spots are formed within the steels. A similar result is obtained by oxidising at a certain rate to form scale on the surface of the steels themselves; but the globules and spots are not obtained when the steels alone are heated *in vacuo*. It thus appears that oxygen is necessary for the formation of the globules and spots. A sufficient supply of oxygen, such as is obtained by certain rates of progressive surface oxidation, appears to increase the size of the individual particles in comparison with that obtained with a limited supply of oxygen as in a scale-filled cavity. The oxygen supplied by the scale in the cavity would be obtained during the initial stages from such oxides as Fe_2O_3, and Fe_3O_4, and during the subsequent stages from FeO, which would cause the main effect. The character of the globules and spots differs according to the elements contained in the steel.

To account for the phenomena described, the author advances the following explanations: The oxygen dissociating from the ferrous-oxide scale within the cavity enters the steel, tending to saturate the surface layers with oxygen in solid solution. Some of the oxygen, however, reacts with those elements in the steel which have a higher affinity for oxygen than has iron. Such elements are chromium, manganese, silicon, aluminium, etc.

It can be imagined that an oxygen atom entering the steel, in its passage through the crystals, comes in contact with, to take an example, an atom of manganese, with which it combines and precipitates as manganese oxide. Further atoms of manganese and oxygen may subsequently diffuse towards this and enlarge it. In addition, atoms of iron may possibly be dissolved in the particle, as well as atoms of other elements, such as silicon, forming in such cases a complex globule or area.

Precipitation of Oxidisable Elements

This precipitation occurs in the first place at random at a number of nuclei in the steel and possibly at the boundaries of the crystals. When progressive oxidation of the steel surface is taking place simultaneously, there will be a removal of the affected area of steel by its conversion into scale. It is conceivable that the rate of scale formation can equal, if not exceed, that of oxygen penetration and precipitation, but the rates of oxidation in air commonly encountered are not fast enough for the latter action to be completely overcome.

Whenever scaling of an article occurs—for instance, during heat treatment—particularly if the surface oxidation is slow, the formation to some extent of globules and spots is to be expected. Whether the affected area is removed by subsequent processes, such as pickling or machining, will depend, *inter alia*, on the extent of the affected area and the amount of metal removed. It would also appear that the more oxidisable elements contained in the steel the greater is the extent of precipitation and formation of globules and spots, so that where a specially good surface is required the steel should contain a minimum of elements having a high affinity for oxygen—that is, any excess of deoxidising agents, such as aluminium, etc., should be at a minimum.

Unless the affected area is removed completely, the effects of the phenomenon on a steel intended to be fatigue-resisting may be to initiate surface cracks. In tinplate manufacture, whilst the affected area, if any, must be extremely thin, owing to the rolling processes, etc., subsequent to its formation, its possible presence cannot be entirely disregarded. It is conceivable that its effect would be to increase the possibility of porosity, particularly if the sheet is to be used for deep stamping. The surface of the sheet containing the non-metallic particles might not be able to withstand the stressing occurring in the process, and minute incipient cracks might be formed at the surface of the steel. The support of the tin coating would not then be continuous, so increasing the liability to failure and the resulting porosity of the coating.

Some Recent Metallurgical Patents

Iron-Chromium Alloys

LOW-CARBON iron chromium alloys of the rustless iron or steel type are made by melting down rustless iron or steel scrap with or without low carbon steel scrap with slag forming material to produce a bath of molten alloy with a strongly oxidising super-natant slag containing iron and chromium oxides and thereafter adding a non-carbonaceous exothermic reducing agent, *e.g.*, a silicon-containing agent, preferably with lime to reduce the iron and chromium oxides, the chromium content of the melt being increased by the addition of chrome ore, *e.g.*, chromite, all or the major portion of which is included in the original charge. The molten charge is initially superheated to a temperature of at least 3,050°F. before the addition of the reducing material. When the major portion of the chrome ore is added with the melt down charge, part of the ore up to 33 per cent of the total may be added during or subsequent to the melt down; the rest of the chrome ore up to 20 per cent is then added with the reducing agents. The preparation of an alloy containing 0.08 per cent of carbon, 17 of chromium, 0.35 of silicon and 0.40 of manganese is referred to. (See Specification 428,950, of Alloy Research Corporation.)

Refining Metals

To eliminate gases such as hydrogen, carbon monoxide and dioxide, nitrogen and cyanogen dissolved in metals or metal alloys by oxidation oxides of the metals or oxygen compounds adapted to form the oxides are added to a bath of the metals or alloys in such proportion that the content of the metallic oxide thus added or formed is less than that of its corresponding metal-metallic oxide eutectic, the oxidation taking place in the presence of an element less noble than the metal or the principal metal of the bath. A less noble element is added to the bath should such not be originally present; for example zinc or phosphorus is added to the bronzes of tin before oxidation and the oxidation is conducted in such manner that traces of zinc or phosphorus remain. Sulphur is eliminated either as a preliminary or simultaneous operation through the medium of a double carbonate of barium and sodium; this treatment is carried out in an oxidising atmosphere in the case of alloys containing tin or zinc and as a preliminary treatment with a reducing medium in the case of copper nickel alloys. (See Specification 429,440, of Compagnie Generale d'Electro Metallurgi.)

New Books on Metallurgy

CHROMIUM STEELS. By R. H. Greaves. Pp. 321. H.M. Stationery Office. 7s. 6d. net.

Although chromium was discovered as long ago as 1797, and an account of its use as an alloying element with iron was given by Stodart and Faraday in 1820, chromium steels were not manufactured commercially before 1865. Even then little use was made of these steels for a considerable time, though to a limited extent they were used in the manufacture of armour plate and projectiles. It was with growing attention to chemical composition and with the development of a definite system of heat treatment that their uses have been widely extended in recent years. The higher chromium alloys, which have outstanding importance as rustless, corrosion-resisting and heat-resisting steels, have been treated in several important books published recently, but information regarding plain chromium steels, that is, steels which have not been modified by the direct introduction of nickel, vanadium and molybdenum, has remained scattered. Nevertheless, these steels have many important industrial uses. They are almost invariably used for balls and ball-bearings, while low content chromium steels have useful properties for structural and general engineering purposes, and are considerably used in the automobile industry. They are also employed for castings for special purposes and for certain types of gauge and die steels, for magnets, for rails and for the exhaust valves in aircraft and other internal combustion engines.

This book gives a comprehensive review of published information on the constitution, treatment, mechanical and physical properties of plain chromium steels, presented in a way which should prove of value and interest to metallurgists and engineers. It also contains a description of some hitherto unpublished work carried out in the Research Department, Woolwich, on the influence of such quantities of silicon and manganese as may be found in the plain chromium steels, and on the influence of mass in heat-treatment. The evidence which has led to the present views on the constitution of the binary and ternary alloys of iron, carbon and chromium is described and illustrated by the necessary diagrams. Many gaps still exist in our knowledge of the constitution of chromium steels, but the present position is summarised and physical data, with which any ultimate conclusions must conform, are quoted in detail. Mechanical and physical properties are discussed in the light of numerical values, which are fully reproduced, and a short account of the principal uses of the plain chromium steels is supplemented by an ample bibliography, dealing with the uses of chromium steels for structural purposes, rails, gauges and dies, ball bearings, magnets, valves. The volume should, therefore, prove to be of value to the engineer as well as the metallurgist, while the chemist, interested in analytical procedure, will find in an appendix (by B. S. Evans) a full critical survey of the methods of chemical analysis suitable for chromium steels.

* * *

A MANUEL OF FOUNDRY PRACTICE. By J. Laing and J. T. Rolfe. Pp. 276. Chapman and Hall. 15s. net.

In the present century, foundry practice has changed from a basis of pure empiricism to one of systematic and scientific control. Thus text-books which in their day were standard works are now obsolete, and those describing modern practice are singularly lacking, a fact which has been deplored on many occasions during the last few years. Messrs. Laing and Rolfe's book should go a long way towards satisfying this need. Not only does it deal fully with the fundamentals, so as to constitute a thorough foundation for the student, but it proceeds to a comprehensive treatment of the advanced technique, thus providing for the needs of the foundry executive, the technical director and the metallurgist. The foundryman is given an account of modern British production, which embodies all those details which are vital to successful practical operation, but which are not to be found in the available text-books. The multifarious design problems which confront the engineer and foundryman to-day—problems which modern production methods seem only to render more complicated, have been systematically dealt with. All sections of the industry, whether green-sand, dry sand or loam moulding, are fully covered, and the manufacture of typical castings made by the various processes is described at various stages of construction with singular completeness. Considerable space has been devoted to gating and running in relation to design, a subject which is of paramount importance in deciding the soundness or otherwise of a casting. The metallurgy and melting of cast iron are fully discussed, while an exhaustive account is given of the applications and methods of manufacture of the alloy cast irons, where recent years have witnessed striking developments. Such subjects as malleable cast iron and chill casting are not neglected, while a special section is devoted to non-ferrous founding. The book is profusely illustrated, and the illustrations themselves are of an extraordinarily high standing, being clearly printed and very much to the point in regard to the subject matter that is adjacent to them. The authors are to be congratulated for having produced a book that is lucid for beginners and yet one which every specialist should have on his shelves. It should prove to be the standard text-book for a decade at least.

Metallurgical Section

November 2, 1935

A Study of Brass Melting Losses

THE metal losses which occur when brasses, and such alloys as cupro-nickel, are melted in crucibles in coke-fired pit furnaces were discussed by Dr. Maurice Cook, of I.C.I. Metals, Ltd., at a recent meeting of the Institute of Metals. He pointed out that the magnitude of this loss may vary considerably for an alloy of any given composition, for it is affected by many factors, such as the method of melting, the type of furnace employed, temperature of heating, precautions for the prevention of oxidation, and methods of recovery. With a given method of melting the loss varies with the compositions of the alloys, those containing readily oxidisable and volatile constituents generally showing higher loss figures than those which do not contain other alloying elements. Two forms of melting were considered, *i.e.*, crucible melting in coke-fired pit furnaces and electric melting in Ajax-Wyatt induction furnaces, and the main purpose of the paper was to present very briefly the results which have been obtained from records kept over a considerable number of years and from experiments which have been made from time to time.

In the crucible melting of metals, which up to quite recently was by far the most common form in the non-ferrous industry, heats of metal are used varying up to and generally not much more than 200 lb. in weight. This form of metal melting—that is, in crucibles in coke, gas or oil-fired furnaces—is still quite widely used, particularly where alloys of different compositions are produced in comparatively small quantities. Here the largest sources of metal loss are the skimmings or dross removed from the surface of the molten metal before casting, splashings, ashes, pot scrapings, and what is known as the stack loss. The latter has always been taken as a difference figure after the other sources of loss have been computed, and it appears to vary from about 0.5 to 1.0 per cent. This stack loss includes moisture, oil, grease, or other combustible matter which is weighed in the casting shop with the heat and so credited as metal. In brass melting the remainder is largely zinc, and the extent of the stack loss varies considerably with the temperature of speltering, with the total proportion of zinc present in the mixture, and the relative proportion of zinc as raw material and in the scrap. The loss of metal in pot scrapings is small and does not generally greatly exceed about 0.1 per cent. In furnaces using solid fuel the ashes from the burnt fuel carry a varying metal content, and is one of the most variable sources of loss. With careful operating technique, however, the amount of metal lost in the ashes should be less than 0.25 per cent. Splashings (the small pieces of metal which are gathered from the floor as sweepings or scrapings, as the result of the spilling of metal during pouring) represent another variable loss, the magnitude of which depends largely on the care and skill exercised in the casting operation.

The stack loss is partially controllable, but non-recoverable. The losses in the ashes, skimmings and splashings are partly controllable and partly recoverable. In the melting of brass the gross loss, which is not usually less than 1 per cent., is in great measure attributable to the relatively large amount of volatile and readily oxidisable zinc in the alloy. Other things being equal, the magnitude of the loss decreases with decreasing zinc content. The gross loss with alloys of the α type for cold-rolling ingots varies from about 1 to 3 per cent., according to circumstances, and with similar melting conditions this is increased to figures varying up to 5 per cent. and even more for common brasses of higher zinc content.

The technique of melting brass in Ajax-Wyatt furnaces is altogether different from that adopted in crucible melting. The latter is an intermittent operation whereas the former is continuous, for in the interests of economy and convenience the furnaces are run continuously and are never completely emptied of metal except at the end of their working life, furnaces capacities of 600 and 1,000 lb. being commonly used. Here some time prior to pouring it is customary to remove the accumulated dross or skimmings from the surface of the molten metal. It is also customary to treat these skimmings by grinding and sieving in order to recover part of their metallic content, ground or sieved skimmings returned to the furnace generally amounting to about half of the total. Since no solid fuel is used, there is no metal lost in ashes. Corresponding to pot scrapings in crucible melting, this item (in Ajax-Wyatt furnace) is merged in the skimming loss, for oxide and dross tend to build up on the walls of the furnaces and are removed once daily or as circumstances demand. In casting, splashing can be regarded as negligible; any metal which does overrun falls on the metal casting platform, and can be picked up and returned to the furnace.

Most of the loss in the Ajax-Wyatt furnace is due to volatilisation and oxidation of zinc. This forms on the surface of the molten metal as dross and it is impossible to remove it without removing some entangle metal. Oxidation is increased by keeping open the lid, spout, etc., of the furnace and so allowing free ingress of air, as well as by the breaking of the surface of the molten metal by stirring and pushing in the solid metal which constitutes the charge. By luting up those portions of the furnace which allowed the air to enter most freely, it was found that the loss could be reduced from the then normal figure of just over 2 per cent. to just under 2 per cent., but this procedure is not practicable for a battery of furnaces in regular use.

Various attempts have been made to reduce the amount of skimmings formed in furnace melting, and hence the metal loss, by modifying the methods of charging the furnace. The use of common salt, in much greater quantities than it is customary to use, has been tried with the object of providing a continuous layer of molten salt over the bath of metal. No appreciable improvement in the respect of reduction of metal losses followed this modification, but when borax was substituted for common salt there was a considerable reduction in the weight of gross skimmings. There is, however, another considerable advantage in the use of borax connected with the recovery of metal from the skimmings. The portion which is recovered after grinding and sieving the skimmings has a metal content of about 80-90 per cent., but when this is returned to a furnace of clean molten metal and stirred in without the use of a flux, not more than about half the metal is recovered as pourable metal with the heat, whereas with the use of borax, most of the metal contained in the "metallic" portion of the skimmings is recovered when it is returned to the furnace.

Cast Iron Research

THE 1935-36 programme of research outlined by the British Cast Iron Research Association indicates a true understanding of the present needs of the cast iron industries. The shrinkage and contraction of cast iron will continue to be an important phase of the work, more especially with regard to the influence of carbon, silicon and phosphorus, and to melting temperature and conditions, pouring temperature and section of casting, using crucible-melted pig irons. Subsequently it is proposed to study the effect on shinkage and contraction of variations in manganese and of additions of alloying elements, as well as the effect on shrinkage and contraction by gases in the melt. In regard to alloy additions, it is hoped to complete the investigations on the influence of copper (up to 5 per cent.) on engineering cast irons, with and without limited additions of nickel, chromium, molybdenum and tin, and with reference to the liquid and solid solubility of copper and its effect on founding properties, mechanical and thermal properties, corrosion resistance, and heat-treatment. An investigation of the effect of molybdenum on the structure and properties of cast iron, with special reference to additions of molybdenum-nickel, molybdenum-chromium and molybdenum-manganese, will also be carried out.

Research on the formation of graphite will be concerned with the formation of fine graphite by the titanium plus oxidation method and the formation of coarse graphite by hydrogen, with the object of ascertaining the ultimate factors governing the structure and properties of cast iron and of evolving methods of conducting these processes on a works scale, and with special reference to differences between crucible and cupola melting. Some attention is also to be given to the mechanical properties of cupola-melted alloy cast irons in the plain and inoculted states, using balanced compositions containing nickel and nickel-chromium, and remelting these irons in the crucible and comparing crucible-melted and cupola-melted irons. In melting practice the Association hopes to complete cupola melts on a series of metallurgical cokes by full-scale trials in co-operation with the L.M.S. Railway at Derby, to determine their relative melting qualities; to carry out tests on similar cokes in their own cupola, to determine carbon and sulphur pick-up; and to co-operate with the Northern Coke Research Committee in special tests on these cokes, with a view to correlating the results and practical experience. Moulding sands and refractories will also receive attention, one phase being an investigation into the properties of the bonding material. Results obtained in service from a wide variety of brick and plastic furnace linings will be examined with a view to evolving recommended types of lining, with special reference to the high temperatures reached in modern foundry melting practice.

Practical Training in Metallurgy

PRACTICAL training in metallurgy at the University of Birmingham was the keynote of Dr. N. P. Allen's presidential address to the Birmingham Metallurgical Society at the opening meeting of the winter session. Metallurgy, he said, was once considered to be a branch of applied chemistry, and in the training of students the chemical aspects of the subject had been predominant, chiefly because students were preoccupied with smelting rather than the application of metals. The important advances made in recent years, however, had come from improvements in the treatment and alloying of metals after the smelting stage had been passed, and it was significant that most of the research work carried out in the post-war period, which reflected the needs of industry during that time, had been on the physical properties of metals and alloys rather than on their chemical properties. Although this changed outlook had been recognised in the metallurgical syllabus of most teaching institutions by the introduction of such subjects as metallography and pyrometry, considerable bias on the chemical side had generally remained.

Under the guidance of Professor Hanson at the University of Birmingham, however, an attempt had been made to correct this bias and thus produce a balanced syllabus to meet the needs of metallurgy as it really exists in industry to-day. This course aims at giving a practical understanding of the numerous changes which metals and alloys undergo in the process of fabrication and adaptation to use. Beginning with the microscopical study of pure metals, common alloys and steels, followed by an introduction to pyrometry, the course proceeds to the manufacture on a small scale of such materials as brass and copper strip or iron castings, the use and effects of hot and cold rolling, annealing and heat-treatment operations being illustrated. Although quantities and sizes suited to the small scale operations are used, every effort is made to keep the processes as close as possible to those in general use, and a point is made of subjecting the finished products to the ordinary mechanical tests and endeavouring to meet standard specifications. In the second year of the course, attention is given to the use of the more recently developed physical methods of investigation, such as the dilatometric and electrical resistivity methods. The dilatometer has been found particularly useful in the study of complex alloy steels, and electrical resistivity in determining limits of solid solubility. Time is also found for work on precipitation hardening, and on the laws of grain growth. The most recent development is concern with the use of X-rays in metallurgical work, students being taught to take transmission photographs, to analyse a simple crystal structure, and to measure lattice parameters with approximate accuracy.

Metallurgy at the National Physical Laboratory

Collected Researches, 1924-34

FROM time to time the National Physical Laboratory collects together papers describing the most important researches that it has carried out, and reprints them under the title of "Collected Researches." In the earliest days of the Laboratory each volume contained papers from several departments, but about ten years ago it was decided to publish the researches of one department at a time. Volumes dealing with physics, electricity and radio, optics, and naval architecture have already been published, and a volume of over 400 pages containing the more important papers emanating from the Metallurgy Department in recent years ("National Physical Laboratory Collected Researches," Vol. 25. H.M. Stationery Office, 25s. net) has now been added to the list.

Equilibrium Diagrams

The equilibrium diagram of an alloy system represents the phases which exist in the system at any composition and any temperature (provided the alloy is in equilibrium). It also indicates the phases which are likely to be obtained on quenching any alloy in the system from any temperature. Experience has also shown that, in a rough degree, certain phases are associated with certain mechanical properties. A knowledge of the equilibrium diagram is therefore fundamental to a study of the age-hardening properties of alloys and, in a lesser degree, to a study of their general mechanical properties. In addition, it is the starting point for much of the recent theoretical work on the inner structure of alloys. It is thus not surprising to find that, out of the twenty-three papers collected in this volume, nine deal directly with the constitution of alloy systems, in five of which iron is the principal metal. Another refers to the technique necessary in determining the constitution of alloys containing mercury, which have (when they contain a considerable excess of mercury) to be polished, etched and examined under the microscope at temperatures low enough to keep them solid.

Effect of Nitrogen on Alloys

In a large number of cases the metals obtainable commercially are not sufficiently pure for the accurate determination of an equilibrium diagram; consequently one paper deals with the effect of an impurity (nitrogen) on chromium and its alloys, while others describe the methods adopted to obtain pure metals. These methods differ in different cases; thus pure silicon has been made by subjecting the commercial metal to chemical treatment, and pure manganese by distilling the commercial variety at about 1,300° C. *in vacuo*. To obtain pure chromium, however, it was necessary to employ a carefully-controlled electrolysis of an aqueous solution of chromic acid. Another point of very great importance in the study of metallic equilibria, especially when it is necessary to use high temperatures, is the choice of suitable refractories for making crucibles, thermocouple protection tubing, etc., and one paper in the present volume of "Electrical Researches" discusses special refractories for metallurgical research.

X-Ray Investigation of Alloy Systems

The comparatively recently developed application of X-rays to the investigation of alloy systems has not been neglected, and, while references to its employment are made in many of the papers referred to above, there are also three contributions dealing specially with this subject. Of the remaining papers, one deals with the optical determinations of high metallurgical temperatures, describing a new determination of the melting point of iron, one with the properties of metallic cadmium, and another with the surface tension of liquid metals.

Ten papers dealing with alloys of iron contain the results of researches on the alloys of iron which were commenced in 1922 under the auspices of the newly-formed Alloys of Iron Research Committee. These papers represent stages in the systematic attack on the study of the alloys of iron with certain other elements. The purpose is to study these alloy systems in the state of the highest possible purity, the absence of carbon being regarded as particularly important.

Purity of Metals and Alloys

The "purity" of metals and alloys is, however, a relative term, and the question presents itself repeatedly, in the course of an investigation of this kind, how far the endeavour to secure purity should be pushed. Recent advances in the knowledge of the effect of apparently slight impurities on metals and on alloy systems suggest that the detailed study of materials of very high purity may lead to the discovery of important facts and of interesting properties. The results of the present research support the same conclusion. For instance, it was thought in the earlier stages of the work that the effect of gaseous impurities need not, perhaps, be considered in the same light as that of solid impurities. The use of nitrogen as a neutral atmosphere was found, so far as existing experimental evidence showed, to have little or no effect on high-purity iron. It was, however, discovered that in the case of chromium and its alloys, nitrogen exerts a marked effect of a very interesting and important kind. Such a discovery, however, while interesting and potentially valuable in itself, constituted a serious obstacle to the progress of the work on the iron-chromium system of alloys, upon which—after the effect had been discovered—a substantially fresh beginning had to be made. In order to avoid the risk of similar difficulties, and of possibly undetected error, in future work on that system and on the iron-manganese and iron-silicon systems, it has therefore been found necessary to prepare the elements manganese, chromium and silicon in the highest state of purity which can be reasonably attained.

Alloys of Iron Research

Three of these papers on "Alloys of Iron Research" deal with the production and, to a lesser extent, with the properties of chromium, manganese and silicon in a state of high purity. It is seen that the standard of purity aimed at is relatively very high, and this involves experimental difficulties and an expenditure of time which increase rapidly as the degree of purity is raised. Another paper in the series deals with the iron-phosphorus system. It represents the completion, under more satisfactory experimental conditions, of an investigation which had been begun some years ago. Phosphorus being readily obtainable in a state of high purity, and the production of pure iron free from foreign substances except where small amounts of oxygen having already been accomplished, progress with the study of the iron-phosphorus system has been possible without the special initial difficulties which have attended the study of the other alloy systems under investigation.

Determination of High Temperatures

A paper on the optical determination of high metallurgical temperatures, by C. H. M. Jenkins, D.Sc., A.R.S.M., and Marie L. V. Gayler, D.Sc., deals in particular with the melting point of iron. It describes the adaptation of the optical pyrometer to the determination of melting, freezing and transformation temperatures in metals and alloys by the observation of a black-body enclosure immersed in the metal. The observations, which were taken at regular time intervals, are plotted in the usual form of thermal curves, preferably of the time-temperature type. Refractory containers in hard

pure alumina were prepared; the crucibles and the method of production are described, and also the precautions necessary to ensure satisfactory black-body conditions. The calibration of the optical pyrometer was carried out by means of the melting points of gold and palladium and intermediate temperatures by comparison with thermocouples. The melting point of gold has been taken to be 1,063° ± 1° C. and palladium 1,555° ± 2° C. The method described has been found suitable for melting point determinations of alloys at high temperatures, but existing thermocouple methods appear preferable for the determination of the transformations in metals and alloys at lower temperatures. The melting point of iron of very high purity, referred to the generally accepted melting point of palladium at 1,555° ± 2° C., has been found to be 1,527 ± 3° C.

Transformations in Gold-Copper Alloys

Transformations in the gold-copper alloys are the subject of a paper by J. L. Haughton and R. J. M. Payne. By recording autographically the variation of resistance with changing temperature of alloys of composition ranging between 20 per cent. and 70 per cent. atomic of gold, and by measurements of the specific resistance of alloys slowly cooled to room temperature, the transformations in alloys with compositions in the neighbourhood of those corresponding with the compounds AuCu and $AuCu_3$ is confirmed, and the presence of another transformation in alloys approximating to the concentration of compound Au_2Cu_3 is established. The microstructure of the alloys is also discussed, whilst a few alloys were subjected to X-ray examination, the report of which appears as an Appendix by G. D. Preston.

The constitution and the physical properties of the alloys of cadmium and zinc are studied in a paper by C. H. M. Jenkins, who investigated this subject by means of heating and cooling curves, and py annealing experiments. Although no intermediate compounds or solid solutions are formed, the alloy system is rendered complex by changes in the zinc-rich solid solutions, caused apparently by the phase changes in zinc, especially by that at about 330° C. The properties of cast and rolled zinc are found to be improved by the addition of small quantities of cadmium. The worked material does not undergo unfavourable alteration on ageing, but the zinc-rich alloys should not be re-annealed except soon after cold-working. A certain degree of quench hardening, followed by age softening, is also found in the zinc-rich alloys; the cadmium-rich alloys, however, soften to their minimum values much more rapidly. The equilibrium diagram shows the existence of increased solid solubility of cadmium in zinc at temperatures above the eutectic lines; this leads to the possibility that in certain alloys further cooling after solidification may lead to partial remelting.

Solid Solubility of Zinc and Cadmium

The mutual solid solubilities of zinc and cadmium in the solid state is reported at several temperatures between 250° C. and 60° C. Results show that although between 1.75 per cent. and 2.0 per cent. cadmium and 2.0 per cent. and 2.25 per cent. zinc are retained in solid solution by the other metal at 250° C., the solid solubility falls to less than 0.25 per cent. cadmium and between 0.75 per cent. and 1.0 per cent. zinc at 60° C. Corrosion tests in rain water and in the normal atmosphere do not show that cadmium accelerates the corrosion of zinc, but a slight inhibitive action probably occurs. The zinc-rich alloys in the cast and rolled states appear to be superior to pure zinc for some purposes, and can be adopted for zinc-base die-casting alloys or for the production of cadmium-bearing zinc sheeting.

Some properties of metallic cadmium is the subject of a paper by C. H. M. Jenkins, with an appendix on the X-ray investigation of cold- and hot-rolled cadmium by G. D. Preston. The physical properties of cadmium were investigated by means of tensile tests, ball hardness tests, and electrical resistivity measurements on "aged" and heat-treated material in the cast, forged and rolled conditions. This research indicates that hardness changes in rolled material which occur at room temperature are markedly affected by slight changes in the conditions of working, such as the temperature produced during rolling, or whether rod or sheet is the subject of examination. At the commencement of cold-working the metal hardens, but a continuance causes softening; after the completion of the process the material hardens spontaneously, attaining a maximum value, as determined by a ball test, after ageing for about 1 hour. By maintaining cadmium cold during rolling, the material produced possesses a high strength in the initial stages of a tensile test, but is markedly softer as soon as extension commences. In the short-time tensile tests, as usually made, worked material is found to be stronger than cast, but cast cadmium appears to be harder than either rolled or forged material in long-time ball hardness tests (time penetration). This phenomenon is confirmed at room temperature by comparative prolonged stress tests in which the rate of steady flow under load for an aged rolled specimen is probably fifty times as great as that of a cast specimen.

Microstructure of Solid Mercury

Some of the changes noticed in this paper are possibly observable in other metals, especially if they recrystallise at approximately room temperature. In the present instance it appears that the recrystallisation temperature is progressively lower according to the degree of previous working and the extent of ageing. In general the behaviour is not dissimilar to that of metals such as iron, in the range of temperature in which recrystallisation readily occurs.

In a paper on the metallography of solid mercury and amalgams, by W. Rosenhain and A. J. Murphy, apparatus and methods are described whereby the microstructure of mercury and dilute amalgams in the solid state has been revealed and examined. Carbon dioxide snow was employed to attain the low temperature required, and specimens having a smooth surface were obtained by solidification against a glass surface or by polishing. The cast surfaces have been etched electrolytically in hydrochloric acid, and, by the use of a device to prevent the deposition of frost on the surface of the specimen or the objective lens, were examined microscopically. Photomicrographs of the structures observed are included.

A paper on the constitution of the alloys of silver and tin, by A. J. Murphy, shows that silver can hold in solid solution 13.3 per cent. of tin at 724° C. and a little less than 11 per cent. at 100° C. The occurrence of a peritectic reaction has been observed, and evidence has been obtained of a transformation at 60° C. C. in the γ constituent, but the inversion said to occur at 232° C. has not been confirmed. The effect of silver on the allotropic changes in tin has been examined; it appears to suppress the transformation from the white to the grey modification.

Constitution of Silver-Mercury Alloys

In a paper on the constitution of the alloys of silver and mercury by A. J. Murphy, with an appendix on the X-ray examination of the silver-mercury system by G. D. Preston, the constitution of the alloys of silver and mercury has been determined over a range of temperature extending from the melting point of silver to −50° C. Progressive additions of mercury to silver cause a continual reduction in the temperature of the initial freezing point down to −38.8° C., the freezing point of mercury. No alloy in the series has a freeping point lower than that of pure mercury. Silver can retain in solid solution 55 per cent. by weight of mercury at 276° C., the amount probably increasing somewhat at lower temperatures. Two intermediate phases of restricted composition are formed. The β phase contains 40 per cent. silver and dissociates on heating at 276° C. into the phase and liquid; the γ phase contains 29 per cent. to 30 per cent. silver, and dissociates on heating at 127° C. into the β phase and liquid.

The surface tension of liquid metals is dealt with in a paper by L. L. Bircumshaw. The surface tension of mercury at ordinary temperatures was determined by the method of maximum bubble pressure. Investigations were made regarding the influence of the material of the tube used, the physical condition of the surface of the end of the tube from which the bubble is blown, and the nature of the gas used for blowing the bubbles. Glass tubes appeared to give slightly higher results than tubes made of silica, and in the case of the latter it was found that roughening the ends (tips) of the tubes was essential before concordant results could be obtained; this did not appear to be necessary with glass tubes.

Determinations were also made for the surface tensions of liquid lead, tin, bismuth, cadmium, zinc and antimony. It is stated that the surface tension of cadmium passes through a maximum at 425° C. Evidence is brought forward to show that bismuth, cadmium and antimony may be highly associated in the liquid state. The surface tensions of a number of lead-tin alloys throughout the composition range from pure lead to pure tin were also determined, at temperatures from just above the freezing point to 800° C. Here it was found that the surface tension of all the alloys decreases with rise of temperature. Small quantities of lead produce a marked fall in the surface tension of tin, but relatively large quantities of tin have very little effect (slight rise) on the surface tension of lead. Assuming that the lead atom has the same dimensions as it has on the solid lattice, and using the method employed by Schofield and Rideal for determining the composition of the surface layer, it is shown that the latter, in the case of an alloy of eutectic composition, may consist of a unimolecular layer of lead atoms.

British Cast Iron Research Association

Annual Report for the Year 1934-35

THE year, which ended on June 30, 1935, was one of the most active and progressive in the history of the British Cast Iron Research Association. Important extensions were made to the development and research programme, services rendered to members increased, and during the year plans were completed for the establishment of the British Foundry School, which opened for its first session on October 15.

It was reported last year that the Advisory Council to the Department of Scientific and Industrial Research had offered to increase its grant to the Association by £2,000 per annum, subject to the receipt from the industry in Great Britain of £7,000 in grant-earning subscriptions. At the same time slight changes were made in the basis on which subscriptions qualify for grant, and in order to raise the £7,000 it became necessary to increase the total industrial income during the year by nearly £1,000. The Council, after careful consideration, decided that it was undesirable to modify the normal subscription scale now in operation, with the result that a much greater income was required from new members than previous experience indicated could be obtained in one year. The Council, however, ultimately reported that the required figure was obtained with the assistance of a group of larger members of the Association, who altogether subscribed a sum exceeding £300 in order to make up the required figure and to ensure the increased grant. The income for the year is thus a new high record, totalling £13,370. As the same assistance cannot be expected this year, the Council now trusts that eligible members will support the Association not only in order to make up the minimum quota of £7,000, but because further grant on the £1 for £1 basis is available for subscriptions exceeding £7,000 to an extent which makes it possible for the Association to reach its ultimate goal of £20,000 per annum.

Research and Development

Following the installation of the Association's cupola furnace of the balanced blast type, referred to in the annual report for 1933-34, the Melting Practice Sub-Committee have undertaken an investigation in co-operation with the L.M.S Railway Company on the melting quality of metallurgical cokes. About twelve cokes were chosen, representative of the material available from the various areas of the country supplying metallurgical coke of the quality normally used in foundry practice. The cokes were then tested over a full day's run at the L.M.S. foundry at Derby, more than fifty tons of metal being melted at each trial, and full observations being taken. Subsequently, arrangements were made for each coke to be tested in the B.C.I.R.A. cupola with charges of known and uniform composition in order to ascertain the carbon pick-up and sulphur-pick-up in the resulting metal. The tests at Derby are now virtually completed and half the tests at Birmingham are completed. Concurrently, laboratory tests on the cokes are being made and the Northern Coke Research Committee (Professor H. L. Riley), which works in close conjunction with the Iron and Steel Industrial Research Council of the British Iron and Steel Federation, kindly undertook to carry out some specialised laboratory tests on the cokes with a view to the correlation of laboratory tests and practical results.

Balanced Blast Cupola

The development of the balanced blast cupola proceeds very satisfactorily. In the annual report for 1933-34 it was recorded that sixty-one cupolas had been installed or were under construction with a total hourly output of 386 tons. At the present time the total number of cupolas installed or under construction is ninety-five, with a total hourly output of 670 tons. They have been installed and operated with entire success not only in this country but in Australia, India, the United States, Denmark, and Czecho-Slovakia. A most satisfactory feature of the development is that many of the furnaces now under construction are further installations in foundries where the system was originally applied to one furnace. The furnace is now to be found in the works of nearly 20 per cent. of members of the Association and it is estimated that the total annual saving in fuel realised by them is approximately three times the total income received by the Association from the industry.

Sands and Refractories

The research programme of the Sands and Refractories Sub-Committee has been extended and an additional investigator appointed to deal with clay-bonded sands. Most founding is carried on in naturally-occurring moulding sands, and based on its previous investigations, the Association has been able to render members assistance with regard to the choice of raw material and the most appropriate grain size, moisture content, ramming density, and the most suitable methods of mixing and treatment for greensand, drysand and loam working. Casting in natural sands is bound to continue to predominate. At the same time developments in modern founding, of continuous production and of large-scale production, have necessitated methods for producing synthetic sands by the addition of clays to silica sands or by the replenishing of the clay bond in natural sands after its destruction by the molten metal. The new investigation is principally con-

cerned with the choice of appropriate clays, the most suitable proportions to add, and the best amounts of moisture and methods of treatment to use.

Difficulties arising out of the shrinkage of grey and malleable iron furnish the greatest problem with which the founder is faced and the development of modern high strength irons has intensified these on account of the high shrinkage of low carbon irons. Difficulties confront any systematic investigation into this matter because shrinkage and contraction are governed to some extent by casting design and the gating and running conditions peculiar to individual foundries, as well as by pouring temperature, section and composition. Furthermore, the shrinkage is also materially affected by the presence of gases in the metal. During the year the Grey Iron Sub-Committee decided to extend the programme by dealing with this question and a special investigator has been appointed. So far, a number of exploratory tests have been made in order to work out a suitable programme, and visits are being paid to the foundries of a number of members where this problem is met with.

Graphite Refinement

Progress on the method of graphite refinement referred to in the annual report for 1933-34 has been slow but definite. The process evolved, which in the interests of members has been covered by British Patent No. 425,227, is as follows: Irons of coarse and open structure containing ordinary total carbon contents are treated to yield graphite in the finest possible form by including in the charge a small amount of titanium of the order of 0.2 per cent. This element can either be incorporated in the pig iron or can be added to the ladle of molten metal from the cupola, or other furnace. The molten metal is then treated with an oxidising gas, preferably carbon dioxide. The work of the year has shown the importance of two points: where the addition of titanium is made at the cupola spout, the ferro-alloy addition employed must have a melting point sufficiently low to permit rapid assimilation into the molten metal. During the year special alloys have been evolved, melting at or about 1,000° C., and these are particularly useful where melting temperatures are low. Secondly, titanium oxidises with such ease that precautions have to be taken to ensure that the ferro-alloy be prevented from oxidising.

Cupola Trials

Following the laboratory experiments on crucible-melted material, a number of cupola trials have been made. The experience gained in both crucible and cupola melts has suggested that the graphite structure of cast iron is governed by the nature and distribution of the slag in the metal and arrangements are contemplated for a more complete examination and analysis of these slags than has hitherto been possible. Indications are not wanting that in the near future national specifications will be required for high-quality irons of tensile strengths up to twenty-two tons per square inch, and, while foundries will probably be left to decide what processes shall be employed and what composition shall be adopted for irons of this quality, it is highly probable that alloy irons will be used. It is desirable that, before these specifications are completed, the basis of testing embodied in B.S.I. Specification 321 should be revised in order to be applicable to the higher quality material. This first national specification for cast iron was issued in 1928, and covered irons of low and medium quality of about nine and eleven tons per square inch tensile strength respectively. An entirely new basis of testing was put forward in that specification, and, while experience has justified the basis adopted, it is clear that in some particulars revision is needed.

The importance of alloy additions to cast iron has justified a further extension of the research programme in this respect, and an additional investigator has been appointed to concentrate on this branch alone. Work done by the Nickel and Alloy Cast Iron Sub-Committee has been in two directions, on the influence of copper and on the influence of molybdenum. The work of earlier investigators on copper has yielded such contradictory results that some systematic work was necessary as copper is already an addition of considerable commercial importance. It is already clear that the influence it exerts depends materially upon the base composition to which the addition is made and the most appropriate addition will be governed by the initial composition. Molybdenum is another addition which has assumed commercial importance and one which produces a marked effect for the quantity added.

Influence of Nickel

The work done on the influence of nickel has now enabled the effect of this addition to be well understood and predictable and its use is steadily extending. The Association's heat-resisting irons, Silal (the ferritic iron high in silicon) and Nicrosilal (the austenitic iron high in silicon and containing nickel and chromium), have made a definite place for themselves for special applications where resistance to heat and resistance to corrosion are important, and the austenitic iron Ni-resist is becoming widely used. The attention previously given to modern high strength cast irons of the type referred to in previous reports as "inoculated" irons has during the year been mainly devoted to graphite refinement, but in the industry there has been a considerable growth of interest in inoculated irons, and for special applications and castings of suitable size and shape, irons approaching a tensile strength of thirty tons per square inch are available.

Tests and Specifications

During the year investigations have been carried out for the Tests and Specifications Sub-Committee on the Association's standard method for the determination of sulphur, described in Research Report 105, and on the alpha-benzoinmonoxime method for the estimation of molybdenum. The Pig Iron Sub-Committee has reconsidered the recommended tolerances for foundry pig iron and foundry refined iron, and has suggested some revisions which it is hoped will in due course be used by the industry. The object of these recommendations is to determine the limits of variation allowable on the amounts of elements in pig iron specified by users.

Leather Pickling Practice

Use of Monel Metal Equipment

A NEW development in the manufacture of tanning machinery is reported by an American firm which has just completed a leather pickling drum made of Monel metal. Normally these drums are made of wood and are rather rough on the hides which become torn or scratched by projecting wood fibres. The damage to hides in these wooden machines amounts to about 22 per cent. of the total charge and it is expected that the smooth surface of the Monel metal machines will enable this damage to be avoided. This figure, incidentally, is based on the losses experienced by an actual tannery due to this cause. In the manufacture of these drums wood has been used in the past largely because of the corrosive effect of the tanning liquors.

Monel metal drums may confidently be expected to resist the action of the brine solutions and sodium dichromate indefinitely because this alloy has already been used to some extent in the form of accessories to wooden equipment. In some instances, Monel metal bolts for this type of equipment have lasted 14 years and are still in good condition. In similar service the life of brass or steel bolts is only from 6 to 12 months, depending on the acid concentration of the solutions used. The danger of hides being spoiled by the presence of stray drops of rusty water is, of course, entirely avoided by the use of Monel metal, which cannot rust and therefore offers no opportunity for damage to the hides.

Metallurgical Section

December 7, 1935

World-Wide Magnesium Production

IN 1930, at the centenary of its preparation as a coherent substantially-pure metal, magnesium was being produced almost exclusively in Germany and the United States. Commercial production in Germany, long the only important source of commercial supply, was begun only a few years before the outbreak of the world war, and for many years processes and production statistics were shrouded in mystery. Even now there is little data upon which to estimate the volume of German production, which is still the dominant factor in world output. The American industry was actually established as a war-time measure, but nearly all the producers ultimately went out of business. Continuance of domestic production after 1922 was made possible only by the imposition of high tariff protection, although the metal at that time was selling at considerably over one dollar per pound, and did not drop below 80 cents per pound until after 1928. The entire domestic output of private magnesium is now obtained from magnesium chloride, recovered as a joint product of the salt wells of the Dow Company, near Midland, Michigan. In 1934 sales of new magnesium ingot and stick jumped to 4,249,838 lb., compared with 1,434,893 lb. in 1933, and a previous maximum of 908,351 lb. in 1929.

In a minor way, magnesium was made commercially in England as well as in the United States some years before the establishment of the German industry, but these early operations were short-lived. Production commenced in France in 1915 as a war-time measure, and was carried on by the Alais, Frogues et Comargue and the Société d'Electro-Chimie, d'Electro Metallurgie et des Acieres Electriques d'Ugine. In 1930 these two concerns amalgamated their magnesium interests in the Société Generale de Magnesium, and the importance of the French industry was indicated early in 1935 by reports that the French Government was proposing to place a ban on exports for national defence reasons. Manufacture of magnesium was not undertaken in Switzerland until 1930. About the same time efforts were made to establish the industry in Soviet Russia; an experimental plant began operations in Leningrad in March, 1931, under supervision of specialists from the Alais, Frogues et Comargue, from France. In Japan the commercial production of the metal was under consideration for a number of years, particularly by the South Manchurian Railway, which has recently organised an affiliate known as the Japan-Manchukuo Magnesium Co. There are now said to be two producers of magnesium metal in Japan, the other concern being the Tokyo Tankai Seizo Koyo.

It was a gradual rise in European prices which finally crystallised plan for the resumption of magnesium production in the United Kingdom, where four leading concerns have joined in the formation of the Imperial Magnesium Corporation, Ltd., the affiliated concerns being the Imperial Smelting Corporation, Ltd., the British Aluminium Co., Ltd., Magnesium Metal and Alloys, Ltd., and Imperial Chemical Industries, Ltd. For the production of magnesium metal on a commercial scale at Randanthein, in Austria, dead-burned magnesite is being used as raw material instead of magnesium chloride, which is generally the basis of magnesium metal production in other countries. In the United States carefully selected caustic calcined magnesite was for some time employed as raw material by the American Magnesium Corporation, the process being similar to the process used in making aluminium metal.

* * *

Tarnishing of Liquid Metals

APPARATUS for the X-ray study of liquid metals up to 700° C. by surface reflection was described by Dr. H. O'Neill and Dr. G. S. Farnham in a paper read before the Institute of Metals at its annual meeting. The primary intention of the investigation described was to study the Debye rings of liquid intermetallic compounds at increasing temperatures, but unexpected and interesting difficulties were encountered in connection with tarnishing. Electron diffraction is the most sensitive method for examining tarnish films, but the positive results obtained with soft X-rays—such as are available in many metallurgical laboratories—seemed worthy of record. Spectrograms taken in an atmosphere of hydrogen just above the melting point of lead and tin, showed the structure of surface tarnish films. On heating to higher temperatures the tarnish was reduced in thickness, and the Debye ring of the liquid metal replaced the X-ray spectrum of the tarnish. Experiments indicated that tarnish formation was really a reversible reaction, and when the metal had been cleared by heating to a temperature approaching 500° C., the tarnish returned during subsequent cooling, 350°-400° C. apparently being the temperature at which films thick enough to be photographed had formed. It is interesting to note that "pure" hydrogen tarnishes commercial brass at 430° C., owing to gas evolution from the brass, but heating to 680° C. removes the oxide film.

Heat-Conductivity of Aluminium Alloys

APPARATUS constructed at the Institut für Metallkunde, Berlin University, has recently been used for the measurement of the heat conductivity of a series of alminium alloys. All the alloys appear to have a substantially smaller heat conductivity than does pure aluminium metal. Even small alloy additions produce this diminution in heat conductivity, but larger additions of alloying constituents do not induce a difference

which is so much marked. For example, no appreciable difference in the heat conductivity results by increasing the silicon content from 1 to 12 per cent. Magnesium alone appears to have a bad effect; aluminium-*manganese* alloys have poor conductivities as a result of solid solution formation. It is the alloys with a heterogeneous mixture of components which give the best heat-conductivity.

Solubility of Hydrogen in Aluminium

FINDING a divergence in the results obtained by other workers, L. L. Bircumshaw has recently made an independent determination of the solubility of hydrogen in molten aluminium (" Trans. Far. Soc.," October, 1935). A method similar to that employed by Sieverts (" Zeit. Metallk," 1929, *21*, 37) who found no solubility, and by Röntgen and Braun, was employed. The apparatus consisted essentially of a calibrated gas thermometer used at constant pressure, the absorbed gas being measured on a calibrated gas burette, and a hydrogen atmosphere being employed. The method consisted in determining the volume of gas required to fill an evacuated tube containing a boat with and without an accurately weighed quantity of aluminium of specially high purity. At the same time special precautions regarding the degassing of the apparatus were observed. Under these circumstances the volume of hydrogen dissolved by the molten metal aluminium was found to be 0.23, 0.89, 1.87 and 3.86 cc. per 100 grams of metal, at temperatures of 700°, 800°, 900° and 1,000° C. respectively, gas volumes being N.T.P. In addition, the saturated heat of solution was calculated from the van't Hoff isochore and was found to be 43,400 calories per gram molecule of gas dissolved.

New Analytical Methods

A NEW gravimetric method for the determination of aluminium has been published by W. Daubner (" Angew. Chem.," September 7, 1935). This new method depends on the production of tertiary aluminium arsenate, $AlAsO_4$, by the reaction between a neutral or weakly acid solution of the aluminium salt and tertiary ammonium arsenate in the presence of ammonium chloride and acetic acid. In order that aluminium arsenate alone shall be produced, the reagents specified must be used in certain concentrations. It is stated that the presence of silicic acid—as in the analysis of silicates—does not interfere with method or accuracy, but in the presence of iron the two metals must be separated before the ammonium arsenate is added. If the original aluminium salt solution contains a mineral acid, the aluminium must be precipitated in the form of hydroxide and redissolved in acetic acid, which is the only acid solution suitable for the application of the method. The order of accuracy, as shown by determinations of aluminium in alums, is said to be in the region of 0.01 to 0.04 per cent. on a 6 per cent. aluminium content.

In the July issue of the Bureau of Standard's " Journal of Research," H. B. Knowles points out that the methods commonly used for precipitating aluminium by 8-hydroxyquinoline from an acetic acid solution, buffered with ammonium acetate, do not sufficiently define the conditions requisite for complete precipitation. He therefore described a new method in which aluminium is precipitated as the oxyquinolate form a solution which has been partially neutralised with ammonium hydroxide, using brom-cresol purple as an indicator. Results obtained in the separation of aluminium from beryllium and magnesium, and in the separation of beryllium in the presence of aluminium, iron, titanium and zirconium, by this method are described.

Determination of Oxygen in Steel

UNDER the joint sponsorship of the United States Bureau of Standards and the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers, an international co-operative study of the various methods which are used for the determination of oxygen in steel is now drawing to a close. In this attempt to define more precisely the comparative merits and the limitations of existing analytical methods, eight steels, each representing a different combination of ferrous and manganous oxides, silica, alumina, and sulphur, within the range of composition of commercial plain-carbon steels, were selected and examined for uniformity of composition. Specimens as nearly identical in composition as possible were prepared and distributed to each of the co-operating laboratories for determination of the oxygen content by the method or methods preferred in that laboratory, reports being sent to the Bureau of Standards for comparison.

Thirty-six laboratories are in active participation in this work, twenty being in the United States and sixteen in other countries. A large number of these laboratories have already submitted their reports, and the assembly and classification of results according to the method used, together with a study of the various procedures, has been started. Although the summary is still incomplete, the divergence of results shows ample justification for undertaking this investigation.

Properties of Carbon Tool Steels

THE mystery which has for many years surrounded differences in the hardenability of steels of quite similar compositions has recently been partly removed by a recognition of the influence of austenitic grain-size on hardening characteristics. The October issue of the " Journal of Research," of the United States Bureau of Standards, contains an article which deals with the influence of the initial microstructure of tool steels on grain-size and hardening characteristics. Widely used brands of 1 per cent. carbon tool steels were classified according to their depth of hardening. From these brands two steels of widely different depths of hardening were selected, and specimens of the steels were so treated as to acquire three different initial structures: (a) Spheroidized cementite; (b) coarse pearlite; and (c) sorbite. A study was then made of the effect of these initial structures on the austenitic grain-size and grain-growth, and on the critical cooling rates, thereby making possible a direct comparison of the relation between austenitic grain-size and critical cooling rate of the two steels over a range of quenching temperatures from 773° to 967° C. The two steels were also compared with respect to their behaviour in the transformation temperature range during thermal analysis, relative rates for the spheroidisation of cementite, relative susceptibility to grinding cracks, hardness on quenching, and the effect of the rate of heating up to the hardening temperature so far as it concerned the depth of hardening.

Black Spots on Tin and Tinned Ware

Their Mechanism of Formation and Their Prevention

UNDER certain conditions, especially in acid or alkaline solutions, tin may undergo general corrosion, involving attack of the whole surface. Under other conditions, particularly in neutral or nearly neutral solutions, local corrosion of tin may occur, when the attack is limited to certain small surfaces. The corrosion products formed are white, basic tin salts, which accumulate round the point attacked, and dark products, which adhere very strongly to the underlying metal base. The dark corrosion products are usually called "black spots."

These black spots, according to Technical Publication No. 2, Series D, of the International Tin Research and Development Council, are found to a greater or less extent on most tinned material exposed to neutral or nearly neutral aqueous solutions. They are observed especially in the dairy industry in equipment in which milk, cream and other dairy products are treated or kept, such as storage vessels for milk and cream, cream-ripening vats and separators, and they constitute a serious difficulty not only in factories making dairy equipment but also in the dairies themselves, as it is often necessary to retin a surface showing numerous black spots.

Appearance and Growth of Black Spots

In spite of the fact that the formation of black spots on tin through corrosion is very common in practice, there is very little to be found about it in the literature. The only detailed publication on the subject is "Korrosion verzinnter Apparate: Ursachen and Verhütung," by Mohr and Schulz ("Milchwirtsch. Zeit.," 1930, 26a-28a, 1037, *et seq.*). From their experiments these authors conclude that the black spots result from a corrosion process of electrochemical nature, due to dissolution of the tin and its transformation by anodic oxidation into a tin compound of black colour. It is also maintained that the black spots may be caused by impurities in the tin (*e.g.*, copper) or by certain constituents in the solution (*e.g.*, sulphur). Although the present author also concludes that the corrosion process is of electrochemical nature, the experiments do not confirm the theory of Mohr and Schulz.

In diffuse light the spots appear quite black; in oblique light they may appear grey. They are very irregular in shape, except when formed in scratches in the tin, in which case they usually extend along the scratches.

The black spots in tinned dairy apparatus generally appear as a result of contact with milk products (usually milk or cream), and not by the action of cleaning media, residual water or the like. They are, in fact, always located at such surfaces of the vessels as are in contact with the milk products.

However, even on these surfaces a certain distribution of the spots can be noted. They are often found at the liquid line, or in proximity to bare copper, brass and bronze surfaces (*e.g.*, near the untinned bronze valves of milk vats). They are also observed on surfaces covered by solid or semi-solid matter (*e.g.*, in a separator, on the parts which become covered with sludge), and at scratches and other injured parts of the surface. The size of the spots varies within wide limits, according to the conditions under which they are formed. In a cream-ripening vat or a storage vessel for milk, for instance, they usually vary from microscopic dimensions to about 1 sq. cm. Spots larger than 3 sq. cm. are rarely found.

Salt Solutions

Black spots can be produced very easily in salt solutions, such as sodium chloride, sulphate or nitrate. Produced in such salt solutions they are apparently of exactly the same nature as those formed by milk under service conditions. For this reason, Mr. Sven Brennert, author of the technical paper under review, has studied the formation of black spots in salt solutions (*e.g.*, sodium chloride), and then applied the results obtained to corrosion occurring in practice. Experiments have been carried out partly on tin-coated surfaces and partly on tin, and it has been found that in both cases corrosion takes place in the same way.

Black spots can be obtained in neutral solutions, such as sodium chloride, sulphate or nitrate solutions; as a rule, the spots are produced more rapidly in the more concentrated solutions. In acid and alkaline solutions the whole surface usually becomes etched. If a freshly tinned surface is immersed in a normal sodium chloride solution, the first attack on the tin can generally be observed within a few hours. The first effect is the formation of a diffuse white product as a certain point on the tin coating. If this is wiped off there is found underneath a microscopic black spot which gradually grows in size.

Mechanism of the Formation of Black Spots

It is generally maintained that corrosion in aqueous solutions is of electrochemical nature. Besides the acceleration of the formation of black spots on a tinned surface by contact with copper, there are good reasons for the view that this type of corrosion is also electrochemical, as is suggested by Mohr and Schulz.

It has been found that the formation of black spots cannot begin on a free tin surface until the surface potential has been increased above a certain potential, here called the "dissolution potential." For the formation of black spots to take place a certain excess potential is, however, often required owing to the fact that the film offers a certain resistance to the current. As soon as the potential has been raised so far above the dissolution potential that the current can break through, the tin begins to corrode with the formation of black spots, which is shown in the time-potential curve by a fall of the potential. The potential of the electrode is then principally dependent on the anodic process.

The formation of black spots on a tin surface not in contact with any other metal thus depends on (1) the potential at which the formation of black spots begins, (2) the rapidity with which the tin surface is ennobled, and (3) the excess potential required to break the resistance of the film.

Composition of Black Spot Substances

The question of the composition of the black-spot substance has earlier been discussed by Mohr and Schulz. Further researches by Mr. Sven Brennert have comprised chemical analysis and X-ray examination of the substance. Investigations have been carried out with the substance of black spots obtained by anodic treatment of a tin coating on stainless steel (0.10 per cent. C., 13.5 per cent. Cr.) in tap water at low current density. The results of the analysis are shown below:—

Analysis of Black-Spot Substance—Solution: tap water; Surface 15.5 sq. dm.; Current: 40 milliamp.; Time: 290 hours.

Analysis.		*Calculated Composition.*	
Sn (total)	81.7 per cent.	SnO	76.3 per cent.
Sn	67.2 per cent.	SnO_2	18.4 per cent.
Fe	0.7 per cent.	Fe_2O_3	1.0 per cent.
			95.7 per cent.

In calculating the composition of the substance from these results the question arises whether all the tin is chemically bound or whether the substance is a mixture of pure tin and tin oxides.

X-ray analysis has been used in an attempt to throw more light on the nature of the substance. The X-ray diffraction figure obtained from the black-spot substance has been compared with those of tin and of stannous oxide produced by boiling an alkaline sodium stannite solution. These three

substances gave different X-ray photographs. That of the black-spot substance contained no tin lines, indicating the absence of elementary tin. Thus, only combined tin can be present. Lines corresponding with those of stannous oxide were also absent in the photograph obtained from the black-spot substance. This, however, may be due to the fact that stannous oxide can crystallise in different systems, or to a difference in hydration. Although the X-ray evidence is not conclusive, on the whole it seems that the main component of the black-spot substance is stannous oxide or a substance closely related to it.

With regard to the mechanism of the formation of black spots it is difficult to find a theoretical explanation covering completely all the observations made. Mr. Sven Brennert has not attempted to put forward any detailed theory of the anodic process, but has contented himself with discussing certain fundamental features. He point out that it thus seems as if the formation of the black spots occurs when a more or less definite minimum current density is reached at the anode surface. This critical current density, which may vary with different solutions, is probably connected with a certain potential difference between the tin and the immediate anode solution (dissolution potential). Above this critical current density (and the potential connected therewith) black spots appear to be produced, while at lower current densities the tin forms only soluble products. In neutral solutions, where the tin is covered by an invisible protective film, the tin will go into solution on anodic treatment only at the comparatively small surfaces at which the film is broken. At such points the effective current density becomes relatively high, even if the absolute current density is low.

The ease of formation of black spots at the sites of scratches is concluded to be due to the relative weakness of the protective film at such parts of the surface. As the film thickens with time it is clear that the newer a scratch is, the greater is the possibility of obtaining black spots in it. In practice the black spots are usually formed during one of the 20-hour periods during which the vessel is in use. When the vessel is emptied and cleaned the conditions are unfavourable for the growth of black spots. When the formation of acid corrosion product ceases, the pH of the solution in contact with the metallic surfaces under the black spots will rapidly increase. This effect is reinforced by the alkaline substances (such as soda and soap) dissolved in the washing water. When the pH approaches the neutral point the conditions apparently become such that a protective film can be formed.

Methods for Preventing Corrosion

There are apparently three different methods by which the formation of black spots can be prevented, (1) by changing the dissolution potential in the noble direction, (2) by changing the single potential of the tin surface in the less noble direction, (3) by reinforcing the protective film so as to prevent the current breaking through.

As the dissolution potential is determined by the composition of the solution, and there is generally no possibility of changing it, this method (1) does not appear promising in practice. There are different ways, however, in which the potential of the tin surface may be lowered (2). For example, the potential can be kept below the dissolution potential by repeatedly washing the surface with a reagent which is capable of dissolving the protective film (*e.g.*, dilute acids). Such substances, which dissolve the oxide film, also attack to a greater or less extent the tin itself, and this method is therefore not suitable in practice. It is also possible to reduce the potential of the tin surface below the dissolution potential by slight cathodic polarisation of the tin. This may be done by connecting to the tin surface another metal less noble than tin (*e.g.*, zinc or aluminium), which metal reduces the potential of the tin surface by forming an electrolytic couple. This latter method has been tried in practice for milk vats and has been found to give very good results.

As regards the last alternative (3), a reinforcing of the protective film generally occurs in practice. In dairy circles the opinion is widespread that tinned containers and equipment which have been treated with special care during the first period of use, corrode more slowly on further use, even if treated less carefully. This is probably connected with the corrosion-preventing properties of the protective film formed during the first period. It is also possible to produce artificially (by anodic oxidation) a film on the surface which offers fairly good protection against corrosion.

Bi-Metals and Thermostatic Metals

Products of British Origin

BI-METALS and thermostatic metals are described in a booklet issued by William Wilkinson, bi-metal manufacturer, Shustoke, Warwickshire.

Bi-metal, *i.e.*, two different metals fused or sweated together to form a composite sheet metal, originated about the middle of the 18th century with the productions of the compound metal known as "Sheffield plate." This material was the invention of Thomas Boulsover, a cutler of Sheffield, in 1742, and may be described as a veneer of silver on copper or brass or other base metal. It was made by tightly binding a smooth plate of silver with iron wire to a thicker, and slightly larger, plate of copper or brass, coating the edges with a paste of borax to prevent oxidation, and then sweating the two together at a red heat in a suitable furnace. The composite plate thus formed was then rolled down to sheets of the required thickness for manufacture into all classes of articles. By this means a sheet was obtained having a hard silver surface of any desired thickness, backed by base metal of greater thickness. In later developments the base metal was plated with silver on both sides, thus giving a composite metal sheet of three distinct layers and having all the appearance of solid silver except at the edges.

Whilst Thomas Boulsover was the inventor of Sheffield plate, Joseph Hancock, a cutler, also of Sheffield, would seem to have been the first to realise the commercial use of the new material. He made candlesticks, tea urns, etc., in Sheffield plate, and in this way the Sheffield plate trade was started in Sheffield. In Birmingham, Matthew Boulton, of Boulton and Watt, took up its manufacture, and would appear for many years to have been the only successful Birmingham manufacturer of Sheffield plate, as he successfully competed in all markets against the leading Sheffield manufacturers.

Perfect bi-metals have been produced by the Wilkinson family for nearly ninety years. The range as now manufactured includes silver on copper (single or double plated), silver on brass (single or double plated), copper on brass, rolled gold (gold plate), striped metals, nickel on brass, contact metals, invar-steel on brass and thermoflex (registered metal).

In every Wilkinson compound metal, a homogenous bi-metal is produced. Many of these bi-metals are pre-eminently suitable for scientific purposes, and others are ideal thermostatic metals. It will be found impossible to separate either by heat or mechanical means one metal from the other—in fact these Wilkinson bi-metals can be heated up to any temperature below that of melting point of one of the amalgamated metals with no detriment whatever to the bi-metal itself.

"Thermoflex," a compound of invar and brass, is the ideal bi-metal for all thermostatic purposes. The special method employed in the Wilkinson process ensures an absolutely rigid and permanent union between the two metals and this fact plays a great part in producing bi-metal strip which will give accurate and consistent results over extremely long periods of use. An interesting feature of thermostatic bi-metal is that it can be bent or worked into suitable shapes according to the design of thermostat, any changes of temperature producing a movement in the bi-metal element in keeping with its original shape.

Some Recent Metallurgical Patents

Extracting Metals

A MELT containing cuprous and silver chlorides, obtained by chlorinating alloys containing 30 to 70 per cent. copper with the remainder consisting substantially of silver, is run into an excess of ammonia solution, the silver being precipitated in metallic form and cupric chloride being formed and retained in solution. When chlorinating alloys contain small quantities of gold, platinum, etc., these may be recovered as a concentrate by stopping chlorination before the alloy is completely transformed. (See Specification No. 432,144, of A. L. Mond.)

Deoxidising Copper

IN a process for deoxidising copper by the violent intermixing of the bath of copper with a molten and fluid slag capable of absorbing the oxides contained in the metal, a metalloid whose oxidation product is more readily absorbed by the slag than copper oxide, is added to the metal bath before or during intermixing or between two successive intermixings, the quantity of metalloid added being lower than that for which the solubility at saturation in the copper of the oxidation product of said metalloid would be exceeded. Examples of such metalloids are phosphorus, silicon and arsenic and the amount used is less than 5 per cent. The slags used contain lime as the main constituent together with oxides of manganese, sodium, iron, magnesium and aluminium. (See Specification 430,869, of W. P. Williams.)

Aluminium-Magnesium Alloys

COLD-WORKED aluminium-magnesium alloys which contain at least 3 per cent. of magnesium, are free from any intentional addition of silicon, and which may contain up to 1.5 per cent. of additional elements such as manganese, zinc and calcium are improved by subjecting the cold-worked alloy or workpiece to an annealing under such conditions of temperature and duration as to preclude recrystallisation of the alloy. The annealing approximates to a duration of between about one to two hours at a temperature between 150 and 200° C. In an example, an alloy containing 7 per cent. of aluminium, 1 of zinc, 0.3 of manganese, and the balance magnesium, was rolled into 1 mm. sheets by the usual hot-rolling process, the final pass reducing the thickness by a further 10 per cent. being effected in the cold and then annealed at 160° C. for two hours. Sheets of similar thickness were produced in a similar manner from an alloy containing 9 per cent. of magnesium, 0.5 of manganese, and the balance aluminium, and then annealed for 1½ hours at 190° C. (See Specification 431,054, of I. G. Farbenindustrie.)

Precipitating Spongy Metals

SPONGY cohesive gold for dental purposes is prepared by precipitating gold from a solution, heating the precipitate in a high boiling liquid, such as concentrated prosphoric acid or commercial (unpurified) sulphuric acid, to a temperature between 150° and 250° C., and washing and drying the precipitate. Preferably a gold chloride solution is neutralised with alkali, heated to 80° C., and the gold precipitated by oxalic acid or sodium nitrate added in excess. The solution and precipitate are then boiled and any gold remaining in solution is precipitated by addition of oxalic acid if sodium nitrite was used for the first precipitation or by addition of sodium oxalate or an alkali if oxalic acid was used. The *p*H of the solution should be between 6 and 7 at this point. The liquid is then decanted off and the precipitate washed in water, heated to between 150° and 250° C. in commercial sulphuric acid, repeatedly boiled and washed with distilled water, and dried below 100° C. The treatment of gold precipitated by formaldehyde, formic acid or hydrogen peroxide is also referred to. (See Specification No. 432,881, of W. W. Triggs.)

Refining Copper

CEMENT copper, in non-briquetted form, is melted down and refined in an internally-heated rotary drum furnace. The cement copper is so charged as to lie on the bottom and both side walls of the furnace and preferably has a moisture content of 6 to 15 per cent., produced by drying and re-moistening, or is preheated to between red heat and its melting point in a drum or circular furnace provided with rabbling arms. (See Specification 430,563, of Nord-Deutsche Affinerie.)

Steel Manufacture

STEEL is manufactured from pig iron containing silicon up to 1 per cent. and phosphorus of about 0.1-1.75 per cent. in basic converter without increasing the phosphorus content of the pig iron by using a preheated blast in the converter. If the silicon content is higher than 1 per cent., namely, up to 2 per cent., cold blast is used until the silicon content is reduced to 1 per cent. or lower and then the preheated blast is used. The temperature of the blast used varies from 200-900° C., according to the amount of phosphorus and silicon present in the pig iron, and the blast may be heated in any known manner, its temperature being regulated, if desired, in any suitable manner, *e.g.*, by the addition of cold air thereto. The tuyères of the converter are made of fireclay having an alumina content of 40 per cent. (See Specification 431,260, of A. M. Malik and S. M. K. Alvi.)

Lead and Lead Alloys

LEAD and lead alloys containing one or more of the metals antimony, bismuth or copper, and also one or more of the elements tin, arsenic, zinc, aluminium, silicon, selenium, tellurium, alkali metals and alkaline-earth metals are refined by treating the molten metal or alloy with caustic alkali and water vapour. The treatment may be carried out in an autoclave or a loosely-covered pot or kettle. Water vapour is introduced as steam, water, a solution of the caustic alkali, or a hydrated compound such as $Na_2CO_3.10H_2O$. Rapid, intimate contact of the reacting substances is obtained by mechanical agitation such as stirring to produce a vortex which draws in the alkali and steam. The process may be used in conjunction with a refining by means of caustic soda and sodium nitrate. The treatment of lead alloys containing specified proportions of antimony and tin, and of bismuth, antimony copper, tin and arsenic is referred to. The temperature may range up to 425° C., but is preferably not over about 350° C. (See Specification 431,355, of A. H. Stevens.)

Hardened Lead Alloys

A HARDENED lead alloy for bearings contains 0.5 to 5.0 per cent. of tin and 0.6 to 2.0 per cent. of calcium, the major portion of the latter being in the form of calcium lead crystals distributed through the body of the alloy. The alloy may also contain 0.02 to 0.1 per cent. of aluminium and 0.1 to 1.0 per cent. of mercury. Instead of mercury or in addition to mercury in quantities of 0.1 to 1.0 per cent. of the following metals may be present in the percentages stated: Silver 0.5 to 2.0, barium 0.02 to 0.1, strontium 0.02 to 0.5, copper 0.05 to 0.5, and manganese 0.05 to 0.5. In the preparation of an alloy, the lead is melted under a suitable flux and aluminium introduced preferably as an alloy containing 50 per cent. of tin. The calcium is then introduced in metallic form or in the form of a lead alloy containing 5 per cent. of calcium. If any of the auxiliary hardeners such as silver, are employed, they may be introduced either in metallic form or in the form of a tin alloy. The melt is then allowed to cool and the slag covering skimmed off or is allowed to solidify, and remelted to about 371° C. and the mercury, if desired, and the rest of the tin added. (See Specification No. 433,653, of S. and T. Metal Co.)

Purifying Iron

METALLURGICAL slag reactions are conducted in an induction furnace constructed according to the parent specification, the induction coils having substantially horizontally disposed axes. The slag forms an emulsion in the molten metal due to the turbulent action. Steel may be produced directly from iron ore or iron oxide in a single operation by feeding ore and carbon into a bath of molten steel or molten pig. The process is of particular advantage for producing steel from slick or fine ores. Reduction of carbon, phosphorous, or sulphur content is greatly accelerated. (See Specification 429,926, of Heraeus Vacuumschmelze Akt.-Ges., and W. Rohn.)

Annealing of Alloys

MAGNETICALLY stable materials for telegraphy and telephony purposes are produced by alloying a basic 40 per cent. nickel—60 per cent. iron alloy with copper, titanium, vanadium, silicon or beryllium to effect an improvement in respect of separation hardness, the addition of copper being more than 10 per cent., or when titanium is employed more than 1 per cent., the alloys being either rapidly or slowly cooled from a high temperature with or without subsequent annealing, their resulting magnetic instability on continuous-current loads being less than 5 per cent. with an initial permeability of 25 or over. (See Specification 429,426, of Allgemeine Elektricitats-Ges.)

Diecasting Alloys

A Brief Survey of Present-Day Compositions

MR. D. H. MUNDEY, of Frys Metal Foundries, Ltd., read a paper on "Die Casting" to the Lancashire Branch of the Institute of British Foundrymen at Manchester on November 2. He pointed out that die casting was generally understood in this country as the method of production by pouring or by forcing metal into highly finished moulds or dies, the result being a casting true to dimension and form, with holes and inserts as might be required, and frequently with internal and external screw threads complete, so that apart from a small amount of trimming and also polishing and plating the casting was ready for service or for assembling into machine parts, without subsequent machining operations.

The alloys employed in the die casting industry were very numerous. Practically the whole family of white metals, that is, those combinations of lead, tin and antimony with or without small amounts of copper, and even cadmium and bismuth could be and were employed to a greater or less extent. Lead base alloys for bearings varied from 5 to 10 per cent. tin, 12 to 15 per cent. antimony and the remainder lead. Sometimes copper and other metals were added for special features, and included many important brands, such as Magnolia, Eyre, Tandem, Atlas, etc. Lead base alloys consisting of lead hardened by the addition of calcium, barium and sodium could be die cast.

Typical Applications

Battery plates and fittings for accumulators were of lead hardened by antimony of from 5 to 10 per cent., and also lead hardened by the alkaline earths. Regulus alloys of special purity for chemical engineering were also die cast. Tin base alloys as used for antifriction metals were all capable of being die cast. These ranged from 93 per cent. tin down to 5 per cent. tin. The high grades were lead free, special additions of the rarer metals being added to give resistance to fatigue stresses. All of these could be die cast if required. Special tin-antimony alloys were used for certain parts of gas meters.

Zinc base alloys were probably the most important family of die casting alloys, though it was a distinction which it might be said that they shared with the aluminium alloys. The alloys in this series were divided into two distinct groups: (1) the older fashioned composition, in which zinc was hardened by the addition of tin and copper, with a small proportion of aluminium; and (2) the alloy which was in most general use at the present time, zinc hardened by aluminium and copper, with a small addition of magnesium.

The first type consisted of tin 7 to 10 per cent., copper 4 to 7 per cent. zinc balance, about 0.2 to 0.5 per cent. of aluminium being added for a double purpose; as a deoxidiser and to prevent the tendency to galvanise the dies and machine parts with which it came into contact at a high temperature. This alloy gave fine finish, great accuracy as to dimension, but it was accused of being liable to age hardening and cracking with subsequent internal corrosion and distortion. Impurities were apt to produce these effects. The strength of these alloys was found to be about nine tons per sq. in. as a practical maximum; they were not ductile. The second type of zinc base alloy contained about 4 per cent. aluminium, 3 per cent. copper, and about 0.1 per cent. magnesium, with occasionally small traces of rarer elements, the remainder zinc. It was absolutely essential that the constituent metals should be of the highest purity possible. Tensile tests gave 18 to 20 tons per sq. in., with a reasonable amount of ductility. This was shown more definitely in a twist or torsion test than by a marked elongation in a tensile test.

For gravity die casting, aluminium with 8 to 12 per cent. of copper was used for pistons for internal combustion engines; manganese up to 1 per cent. was sometimes added, but it decreased the thermal conductivity. Y alloy, consisting of magnesium 1.2 to 1.7 per cent., nickel 1.8 to 2.3 per cent., copper 3.5 to 4.5 per cent., and aluminium, remainder, was an excellent alloy which was capable of heat treatment which improved its physical properties. Gravity die castings in aluminium bronze were as strong as a medium-grade steel, had a beautiful skin and colour, and the machined surface was like gold; they resisted corrosion to a marked degree, and were very reliable.

Pressure Castings

For pressure die castings, the alloy of 11 to 13 per cent. silicon, remainder aluminium, was absolutely first favourite. There were many special alloys which had high properties and were highly recommended in view of their strength ductility and resistance to corrosion, the most recent being called Ceralumin.

Both gravity and pressure work were successfully carried out in brasses of approximately 60 per cent. copper, 40 per cent. zinc. It was this alloy which was the basis of brass pressure die castings. A feature of the work was the production of the castings at a temperature between the solidus and liquidus, the consistency of the metal being that of melting snow, and the production of the casting under high pressure.

Excellent results were obtained and the process, which was past the experimental stage, was full of promising possibilities. Tensile strengths of over 25 tons to the sq. inch were obtained. This result would no doubt be increased, but there was one handicap. The high stresses upon the surface of the die, coupled with the high temperature and the speed of the metal travelling over the die face, produced a crazy pattern of hair-like lines upon it; these gradually deepened, and thus in most cases the die life was short. It was possible that this might be overcome in time, and researches into various kinds of alloy steels and heat treatment were going forward.

THE

SCOTT

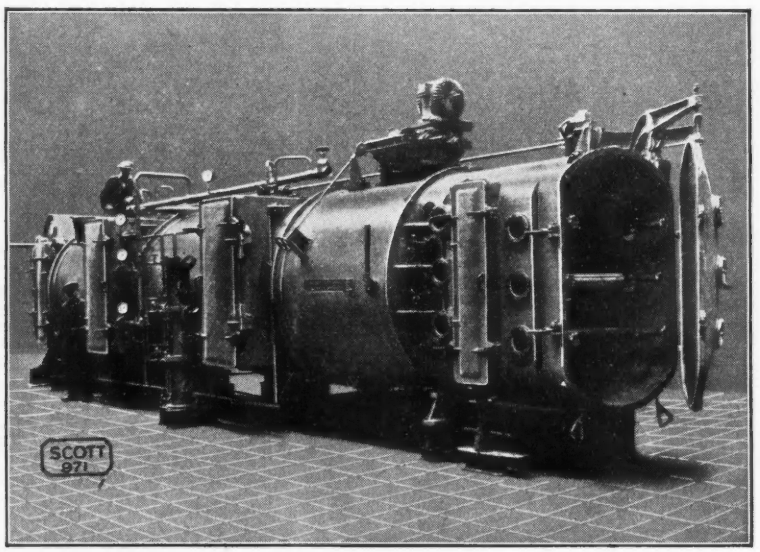
PATENT HIGH VACUUM

• BAND DRYER •

AN ORIGINAL DESIGN

embodying experience on a wide range of products

AVOID IMITATIONS



PATENT VACUUM BAND DRYER, FOR PASTES AND DELICATE PRODUCTS, WORKING UNDER HIGH VACUUM WITH CONTINUOUS FEED

The Dryer which towers above all others for the drying of delicate products where colour, flavour, structure, risk of deterioration during drying, etc., are vital considerations

Already installed in five sizes

Experimental plant available at our research works

GEORGE ERNEST SCOTT & SON (LONDON) LTD. & CO., LTD.

Artillery House, Artillery Row, LONDON, S.W.1

INDEX TO ADVERTISERS

Where the folio number is not shown the advertisement appears at regular intervals.

Numerals before names of firms show page numbers of advertisements in "The Chemical Age Year Book" for 1935.

Acheson, E. G., Ltd. ..... —
Airey, R., & Son xxxiv
97 Alcock (Peroxide), Ltd. ... —
Aluminium Plant and Vessel Co., Ltd. xxiii
Atlas Syndicate, Ltd. xxxiv
Automatic Coil Winder & Electrical Equipment Co., Ltd. ..... —

Bailey, Sir W. H., & Co. Ltd. ..... —
101 105 Barter Trading Corporation Ltd. ..... —
Bausch & Lomb Optical Co., Ltd. ..... —
Benn, Ernest, Ltd. xiv
47 Birmingham Battery & Metal Co., Ltd. ..... —
Black, B., & Son xxxiv
Blagden, Victor & Co. Ltd. xxxiv
Blairs, Ltd. ..... —
Boome, Geo. F., & Son Cover ii
101 Boots Pure Drug Co., Ltd. —
92 Bowman's (Warrington), Ltd. xxxii
Bowran, Robert, & Co. (1934), Ltd. ..... Cover ii
Braby, F., & Co., Ltd. ... —
107 British Association of Chemists xxxii
British Commercial Gas Association v
87 British Drug Houses, Ltd. —
British Tar Products, Ltd. —
British Thomson-Houston Co., Ltd. xxvi
Facing third Cover Brough, E. A., & Co., Ltd. —
Brown & Co. xvi
90 Brown & Forth, Ltd. ..... —
Burdick, C. L., Mfg. Co. ... xxxv

Cafferata & Co., Ltd. xxxvi
Callow Rock Lime Co., Ltd. xxxvi
61 Carty & Sons, Ltd. iv
Central Pulverising Co., Ltd. xxxiii
70 Chesterfield Tube Co., Ltd. —
61 Christy & Norris, Ltd. ... —
48 Clayton, Son, & Co., Ltd. —
Clifford, Chas., & Son, Ltd. ..... —
Copes Regulators, Ltd. ... x
Crepin & Doumin, Ltd. ... xxxiv
Croda, Ltd. xxxvi

Dalheim, T. G. ..... —
36 Davey, Paxman & Co., Ltd. x
Detel Products, Ltd. ..... —
Dexine, Ltd. ..... —
57 Dick, R. & J., Ltd. xviii
51 Dorr-Oliver Company, Ltd. xxviii
34 Doulton & Co., Ltd. ..... —
Dunlop Rubber Co., Ltd. —

Electromersible Motor & Pump Co., Ltd. ..... Cover iii
Enamelled Metal Products Corporation (1933), Ltd. iii
48 Evans, Adlard & Co., Ltd. xx

52 Feltham, W. H., & Son Cover iii
Flatau, Dick & Co. ..... —
Foamite Firefoam, Ltd. ... —
30-31 Follows & Bate, Ltd. vii
Four Oaks Spraying Machine Co. ..... —
Fuller, W. N., Junr. ... Cover iii

Gallenkamp & Son, Ltd. xxiv
Gardner, Wm., & Sons, Ltd. ..... —
Gas Light & Coke Co., The xii
92 General Chemical & Pharmaceutical Co., Ltd., The ..... —
Glycerine, Ltd. ..... —
Gray, J., & Sons, Ltd. ... —
46 Guelph Cask Veneer & Plywood Co., Ltd. xx
Guthrie & Co. ..... —
G.V.D. Illuminators, Ltd. xxii

56 Harris, P. L. & G. S., Ltd. ..... —
Hathernware, Ltd. xxx
Haughton's Metallic Co., Ltd. ..... —
Haworth, F. xxxv
Hearson, Chas., & Co., Ltd. —
91 Hill-Jones, Thos., Ltd. ... ix
Hopkin & Williams, Ltd. xxxvi
Horne Engineering Co., Ltd. ..... —
Howards & Sons, Ltd. ... xxxi
Hurrell, G. C. & Co., Ltd. xvi

95 Imperial Chemical Industries, Ltd. xxv
Institute of Chemistry xxxiii
53 International Pulverisers, Ltd. xiii
42 Isler, C., & Co., Ltd. ..... —

Jackson, Fredk. & Co., Ltd. ..... —
Jenkins, R., & Co., Ltd. ... —
84-85 Johnson Matthey & Co., Ltd. xv
Jones & Co. (Methylators), Ltd. ..... —

Kelvin, Bottomley & Baird, Ltd. ..... —
Kent, George, Ltd. ..... —
59 Kestner Evaporator & Engineering Co., Ltd. ..... —
Key Engineering Co., Ltd. Cover ii
Lancaster & Tonge, Ltd. Cover iii
Langley, London, Ltd. ... —
Back Cover Laporte, B., Ltd. xxvii
Leeds & Bradford Boiler Co., Ltd. xxxiv
38 Leigh & Sons xxxvi
Leitch, J. W., & Co., Ltd. ..... —
Lever Bros., Ltd. ..... —
London & Lancashire Insurance Co., Ltd. ..... —
68 Lord, John L. xxiv

Manchester College of Technology xvi
Mavor & Coulson, Ltd. ... —
68 Medway Paper Sacks, Ltd. xvi
Meldrums, Ltd. ..... —
Metal Traders, Ltd. xviii
103 Methylating Co., Ltd. ..... —
Metropolitan-Vickers Electrical Co., Ltd. ..... —
74 Mills-Packard Construction Co., Ltd. ..... —
Mitchell, L. A., Ltd. ..... —
88-89 Monsanto Chemicals, Limited ..... —
Moritz Chemical Engineering Co., Ltd. ..... —
Moseley, David, & Sons, Ltd. ..... —
Muirhead & Co., Ltd. ..... —
Myers, C. xii

Negretti & Zambra ..... —

Oertling, Ltd. xvii
80 Ohlenschlager Bros., Ltd. —
Third Cover Oxley Engineering Co., Ltd. ..... Cover ii

83 Pamolene (England), Ltd. —
75 Paterson Engineering Co., Ltd. ..... —
Pease, W. H., & Co., Ltd. Cover iv
Perry & Hope, Ltd. xxxiv
50 Potter, F. W., & Soar, Ltd. ..... —
Poulten, Selfe & Lee, Ltd. —
Premier Filterpress Co., Ltd. xxxvi
98-99 Price, Stutfield & Co., Ltd. ..... Front Cover
Prodorite, Ltd. xxviii
100 Pyrophosphate & Cream Powder Co., Ltd. ... Cover iv

58 Reads, Ltd. ..... —
Redwood Export Company —
Restlight, Ltd. xxxv
Rising, Hy., & Son xxxvi
Robinson, F., & Co. Ltd. ... —
60 Rowlandson (W.), & Co. ... xxiv

65 Scientific Glass Blowing Co. xxxii
Schott & Gen. xii
Scott (G.), & Sons (London), Ltd. i
100 Shawinigan, Ltd. iv
82 Silica Gel., Ltd. ..... —
55 Simon, Richard & Sons, Ltd. ..... —
93 Sofnol, Ltd. vi
83 Spence, Peter, & Sons, Ltd. ..... —
102 Spencer Chapman and Messel, Ltd. ... vi and xxxii
Spiral Tube & Components Co., Ltd. xviii
Staveley Coal & Iron Co., Ltd. xix
Stewarts and Lloyds, Ltd. —
Sutcliffe, Speakman & Co., Ltd. ..... —

57 Thermal Syndicate, Ltd. xi
41 Thom, John, Ltd. ..... —
Thompson, John (Dudley), Ltd. viii
40 Todd Bros. viii
Towers, J. W., & Co., Ltd. xviii
86 Tyrer, Thos., & Co., Ltd. xxi

40 & 56 Valor Co., Ltd. xx
79 Viaduct Alum Co., Ltd. ... —

61 Wallach Bros., Ltd. ..... —
63 Wells, A. C., & Co., Ltd. xx
110 Wengers, Ltd. xxxiv
Western Chemical Co. (Paisley), Ltd. xxii
Whitaker, B., & Sons, Ltd. —
Wiggin, Henry, & Co., Ltd. xxx
Wild Barfield Electric Furnaces, Ltd. ..... —
Wilkinson, Jas., & Son, Ltd. ..... —
Wilkinson, William xxxiv
73 Windsor, H., & Co., Ltd. —
Wood & Fairweather xxxvi
Worthington-Simpson, Ltd. xiv

For Sale and Wanted xxxii
Patents and Trade Marks xxxiii
Working Notices xxxiii

Comprehensive Buyers' Guide Sections appear in "The Chemical Age Year Book," a copy of which is sent free in December to every yearly subscriber to "The Chemical Age"

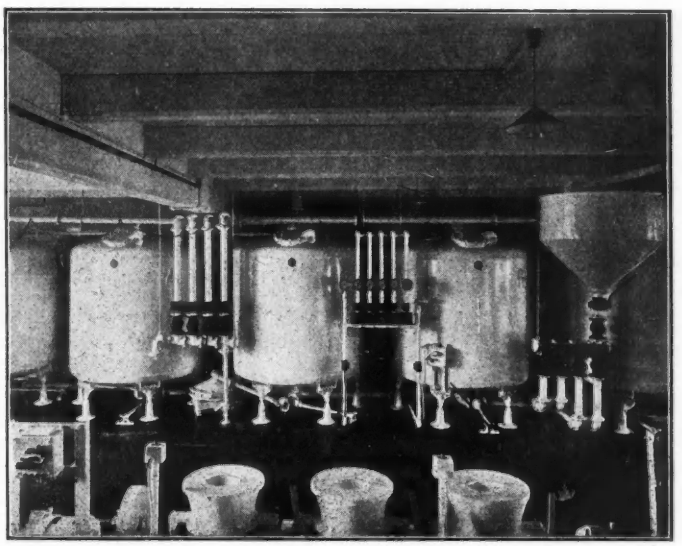
PFAUDLER

GLASS LINED EQUIPMENT

Is it here?

Pfaudler Glass Lined Equipment is used for processing a wide variety of chemical products. The following list is merely indicative of its application. Additional lists will appear in subsequent advertisements. If you manufacture any of the products mentioned, Pfaudler Equipment will interest you.

Acetic Acid
Acetone and Alcohol
Aluminium Sulphate Solution
Distilled Water
Essential Oils
Ferric Chloride
Formaldehyde
Gums
Iodine Solutions
Lacquers
Oleic Acid
Salicylic Acid
and hundreds of other compounds



"Pfaudler" Glass Lined Mixing and Storage Tanks for "Kolynos" Dental Cream. By courtesy of Messrs. Kolynos Ltd., London.

Pfaudler Glass Lined Plant solves the problem so frequently encountered of reproducing, in full scale operation, processes which have been perfected in glass vessels in the laboratory. Why incur the risks of contamination and discoloration due to metals and alloys, as well as possible corrosion of costly plant ?

We probably have a suitable standard Pfaudler Glass Lined Unit.

If not, with your co-operation, we are ready to design and fabricate specialised equipment to meet your requirements. May we send you our latest booklet covering the needs of the chemical industry ?

Enamelled Metal Products Corpn. (1933) Ltd.

Artillery House :: Artillery Row :: London, S.W.1.

Works : Leven, Fife.

C.A., 28-12-35

MADE IN CANADA

SHAWINIGAN

SHAWINIGAN LIMITED

ACETIC ACID

CARBIDE of CALCIUM

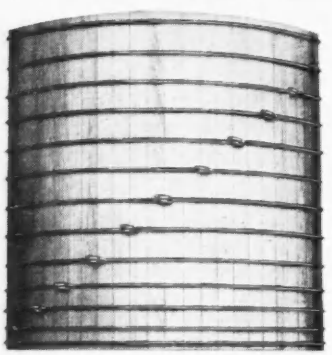
PARALDEHYDE

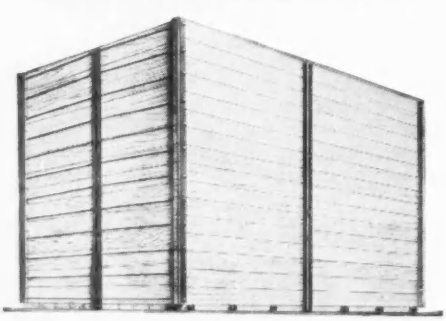
ACETYLENE BLACK

POLYVINYL ACETATE
"GELVA"
High and low viscosities
POLYVINYL ACETALS
"ALVARS"

MARLOW HOUSE, LLOYDS AVENUE,
LONDON, E.C.3.

Telephone: Royal 4312/3. Telegrams: Iganshawin, Fen, London.





WOOD VATS AND TANKS

50 Gallons to 150,000 Gallons Capacity

Carty's specialise exclusively in the manufacture of Wood Vats and Tanks for all trades, and are famous for the reliability and long life of their vessels.

The Secret of this Success is—

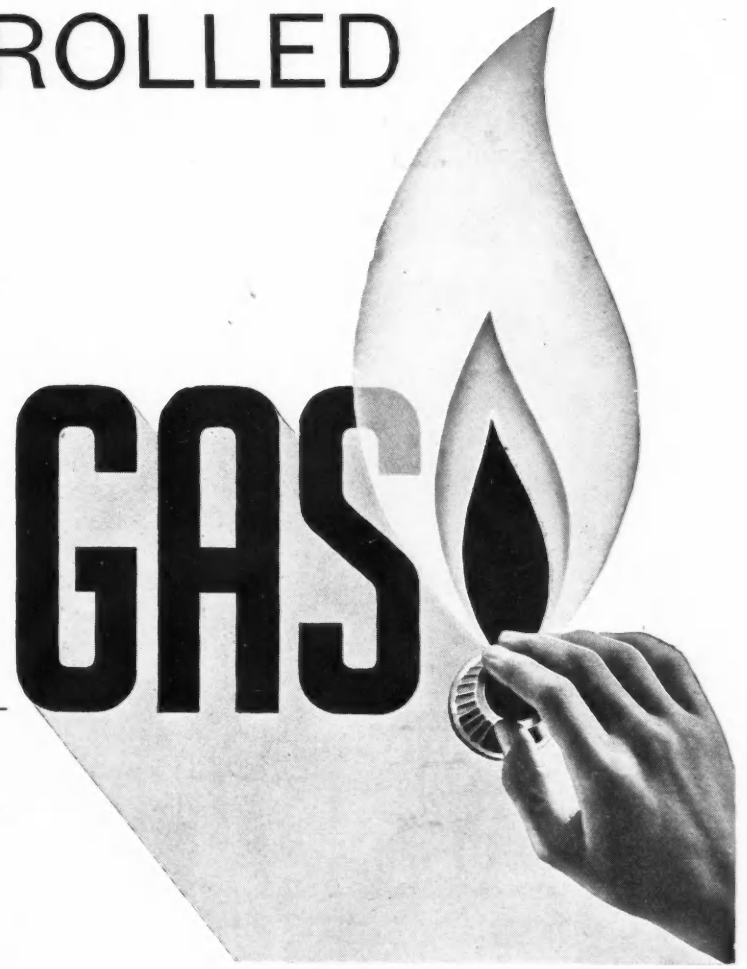
1. Properly seasoned Timber.
2. Strict elimination of natural defects from Timber.
3. The accumulated experience of over 150 years' continuous manufacture of Chemical Vessels.

CARTY & SON LTD.

HARDERS ROAD, PECKHAM, LONDON, S.E.15
PHONE: NEW CROSS 1826 EST: 1766

The cheapest CONTROLLED heat—

GAS



The significant thing about gas is that the *new* industries—television, plastics, aeroplane manufacture—swear by it as a fuel just as much as the older industries. And they use continually more and more. Why? First, gas is cheap—not only on actual cost, but because it eliminates fuel and ash handling and storage space, and reduces supervision to a minimum.

Second, because gas is so easily and accurately controlled. The required temperature can be reached in a shorter space of time, and held more accurately than by any other fuel.

Third, *gas never fails.*

The Gas Industry is anxious to help you apply Gas to your processes conveniently and economically. Write to the

BRITISH COMMERCIAL GAS ASSOCIATION
28 GROSVENOR GARDENS, LONDON. S.W.1

The Key To Absolute Reliability in

SCM BRAND

ACIDS

OLEUM
ALL STRENGTHS

SULPHURIC

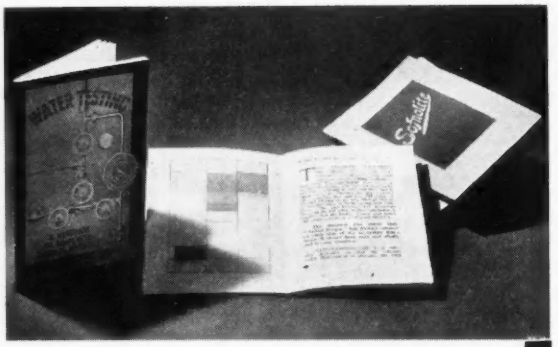
HYDROCHLORIC
MURIATIC

NITRIC
DIPPING AND MIXED

SPENCER CHAPMAN AND MESSEL LIMITED
WALSINGHAM HOUSE, SEETHING LANE
LONDON, E.C.3.

Telephone :
Royal 1166 (3 lines).

Telegrams :
"Hydrochloric Fen—London."



★ *We will gladly send you FREE any of the following—*

"CALCIUM HYDRATE."
Describing the properties of pure Calcium Hydrate as a standard alkali for chemical processes and water treatment.

"CHEMISTRY OF WATER SOFTENING."
A handbook for every Engineer and Chemist responsible for Water Softening.

"WATER TESTING."
On simplified methods of testing necessary for the control of the quality of water supplies.

"SODA-LIME."
Describes new grades of this reagent of increased absorptive capacity for all purposes.

"SOFNOLITE."
A handbook for every analyst. Describes an economical solid gravimetric CO_2 absorbent.

"INDICATORS."
How modern indicators increase the accuracy of volumetric analysis.

Please write to-day for your FREE copies of these interesting booklets—or telephone **Greenwich 1600** *and*

TALK IT OVER WITH SOFNOL

SOFNOL LTD.
WESTCOMBE HILL
GREENWICH, S.E.10

MACHINERY FOR
PAINT MANUFACTURE
AND
OTHER PRODUCTIONS

THE VERY LATEST MACHINERY

We are the leading specialists in the design and manufacture of all kinds of machinery for paint and similar manufactures. Here are illustrated four types of specialised machinery, and details of others, manufactured by us, will gladly be sent on application.

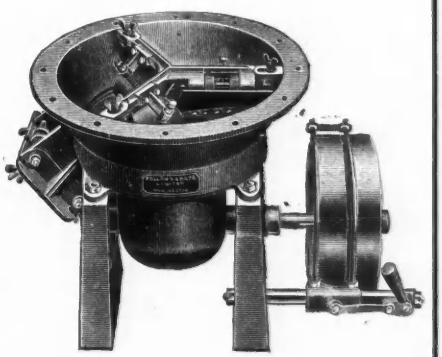
We undertake complete schemes for specialised business undertakings and give free advice on all manufacturing problems.

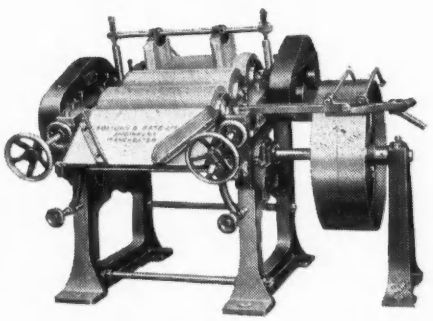
THE PATENT "CIRCULATOR" MILL.

The world's best high-speed Liquid Grinding and Emulsifying Mill.

THE "IDEAL" ROTARY KIBBLER.

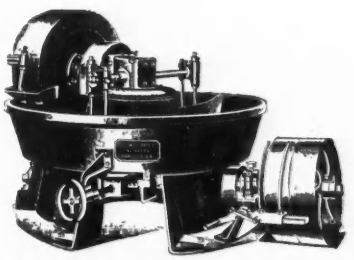
For breaking down **Lump Pigments, Dyestuffs,** etc., to either rough powder or small pieces suitable for feeding into **Disintegrators** and other **high-speed Grinding Mills.**





TRIPLE ROLLER MILL.

For amalgamating and finishing white lead, zinc white, oxides, paints, etc.



HEAVY IRON EDGE RUNNER MILL.

A strong, durable mill suitable for mixing and crushing a great variety of materials, either wet or dry, in water or in oil.

FOLLOWS & BATE Ltd.,
GORTON, MANCHESTER

Telephone : East 0081-0082. *Telegrams : "Climax, Gorton."*

New Year Greetings and Best Wishes for a Prosperous 1936

WHY NOT SAVE ON PACKING?
It is our job to help you to the best and cheapest methods. We have over half a century's experience.
TODD BROS
MAKERS OF QUALITY DRUMS
WIDNES, LANCS.
Full Details on Request

TYPICAL EXAMPLES OF OUR PRODUCTS.

Autoclave, Homo-lead lined for Dye-Stuffs Plant.

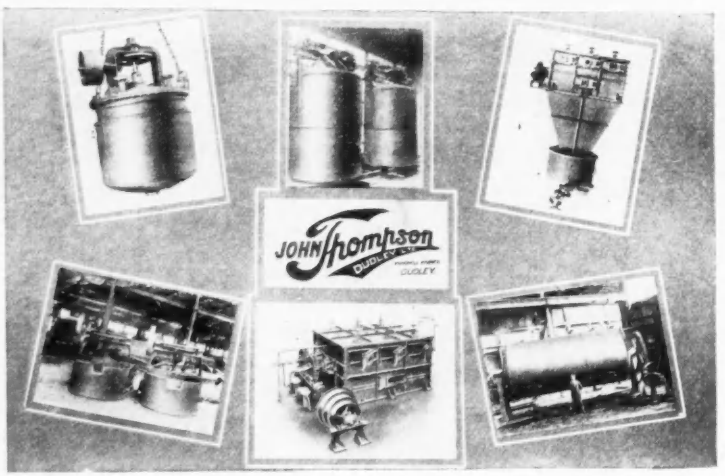
Mixers sprayed internally for Art. Silk Dope.

Vacuum Dryer for Fine Chemicals.

Filter-mixers for Sugar-Refining.

Double-drum Dryer for Flaked Products.

Rotary Digestor for Paper Mills.



CHEMICAL PLANT IN STAINLESS AND NICKEL-CLAD STEELS NICKEL, MONEL, INCONEL.

BY JOHN Thompson DUDLEY LTD WINDMILL WORKS, DUDLEY.

SEVENTEEN YEARS' EXPERIENCE IN HOMOGENEOUS LEAD LINING AND COATING.

BACKED BY A CENTURY'S EXPERIENCE.

LONDON OFFICE : IMPERIAL HOUSE, KINGSWAY, W.C.2.

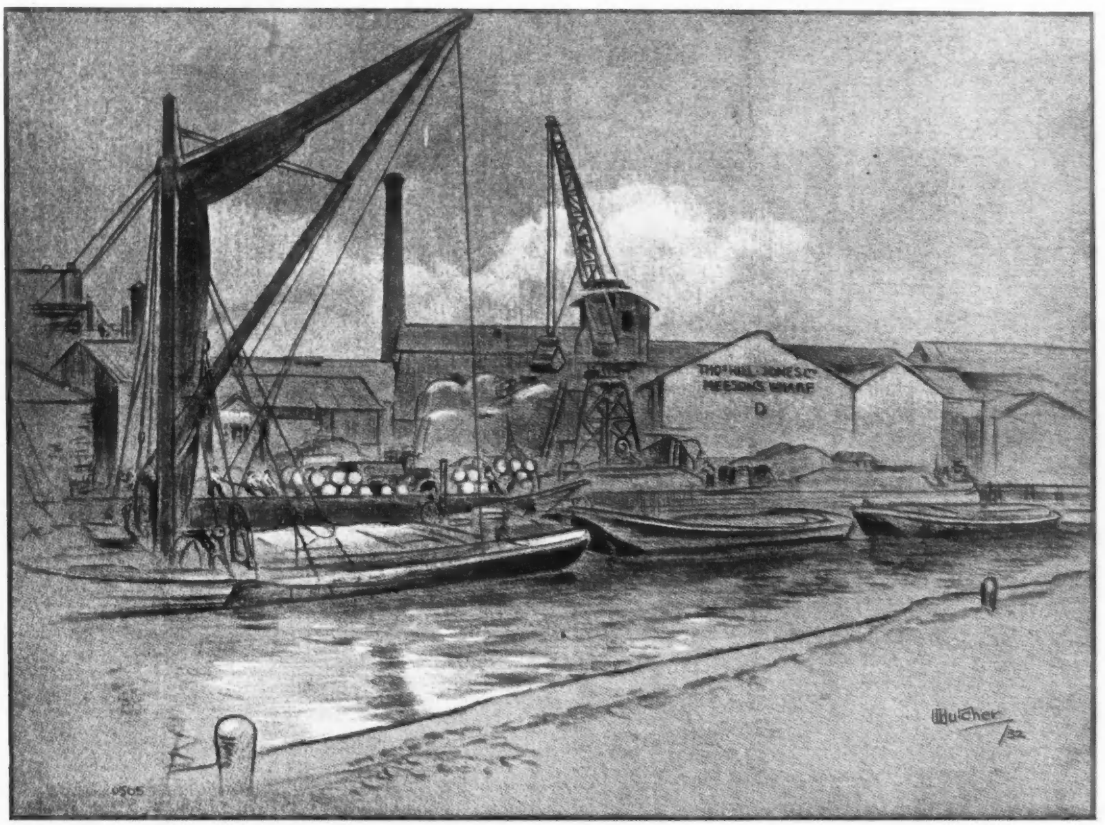
GRINDING OF EVERY DESCRIPTION

of chemical and other materials for the trade

Old-established but up-to-date in every detail, our organisation provides a specialised service for the chemical industry that ensures rapid delivery and low prices

Manufacturers and proprietors of

"INVICTA" DECOLOURISING CARBON. PLUMBAGO. WOOD AND ANIMAL CHARCOAL. MANGANESE. "INVICTA" BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION.



Meeson's Wharf

THOMAS HILL-JONES, LTD.

MANUFACTURING CHEMISTS

INVICTA WORKS, BOW COMMON LANE, LONDON, E.3

and at Meeson's Wharf, Bow Bridge, E.15

Telephone : East 3632 and 3633

ESTABLISHED 1830

CONTRACTORS TO H.M. GOVERNMENT

Telegrams : "Hill-Jones Bochurch, London"

COPES AUTOMATIC BOILER FEED REGULATORS

Are Controlling:—

139 BOILERS

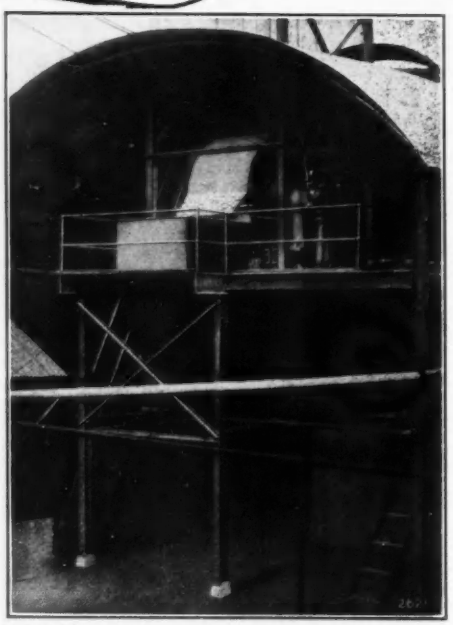
IN YOUR INDUSTRY

ENSURING CORRECT WATER LEVEL
& BETTER COMBUSTION EFFICIENCY

ASK US WHY?

COPES REGULATORS LTD.,
BURLEY HOUSE, THEOBALDS RD., LONDON, W.C.1

Paxman ROTARY VACUUM FILTERS



A SIMPLE AND EFFICIENT METHOD OF REDUCING THE COST OF FILTERING CHEMICAL AND METALLURGICAL SLURRIES.

THE illustration alongside is a photograph showing a PAXMAN Filter Plant recently installed in the West of England dealing with Caustic Lime Mud direct from the causticisers, without any previous settlement of the solids, decanting and washing.

PAXMAN Filters are continuous in operation, require practically no attention, whilst the repairs and upkeep charges are negligible, and the power consumption very low.

THE PAXMAN TECHNICAL SERVICE IS AVAILABLE FOR ANY FILTERING, THICKENING OR CLARIFICATION PROCESS.

Write for Leaflet No. CB 1073.

DAVEY, PAXMAN & CO. (COLCHESTER) LTD.
LONDON OFFICE: ALDWYCH HOUSE, W.C.2. COLCHESTER

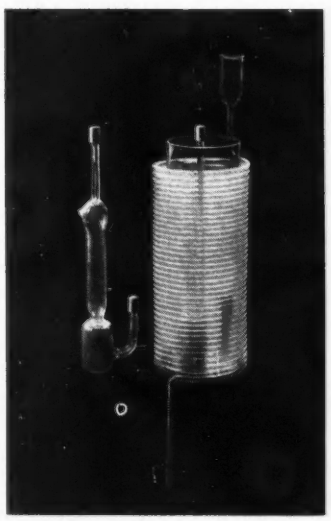
ULTRA VIOLET LIGHT
AT THE
TURN OF A SWITCH

After over 25 years of manufacturing mercury vapour lamps for the trade, we know that a portable self-contained self-starting Ultra-Violet Ray Unit is greatly needed. The VI-TAN Unit fills this need. Simply plug into any standard lamp socket or radiator connection and switch on. Ultra-Violet light is immediately available. The unit can be used in any position and in spite of a consumption of only 50 watts gives a powerful Ultra-Violet beam. The VITREOSIL (pure fused quartz) mercury vapour lamp gives 99 per cent. of its radiation in the Ultra-Violet, hence its low current consumption in comparison with its U.V. output.

VI-TAN

For Alternating Current only.

MERCURY VAPOUR LAMPS of all types, arc and discharge, can be supplied for scientific and industrial purposes. For example, we illustrate an apparatus for irradiating liquids which is extensively used. The lamp, also shown separately, is contained in the transparent beaker which is surrounded by the coil through which flows the irradiated fluid. All equipment is made of transparent VITREOSIL which passes U.V. light down to 1,850A° at over 80 per cent. (minimum) efficiency. We shall be pleased to quote for your requirements.



THE THERMAL SYNDICATE LTD.

Vitreosil Works, Wallsend-on-Tyne.

London Depot : Thermal House, Old Pye Street, S.W.1.

THE GAS LIGHT & COKE COMPANY

Salesman's Office : Dauntsey House, Frederick's Place, Old Jewry, London, E.C.2

STAND No. A178

have placed this space at the disposal of
The Association of British Chemical
Manufacturers to invite you to examine

BRITISH CHEMICALS
AND
COAL TAR PRODUCTS

at the

BRITISH INDUSTRIES FAIR, 1936

Chemical Section, Main Hall, Olympia, W.14

February 17th—28th, 1936.

Jena fritted Glass Filters

indispensable for the chemist

filtration and clarification of liquids and gases

gas washing

extraction

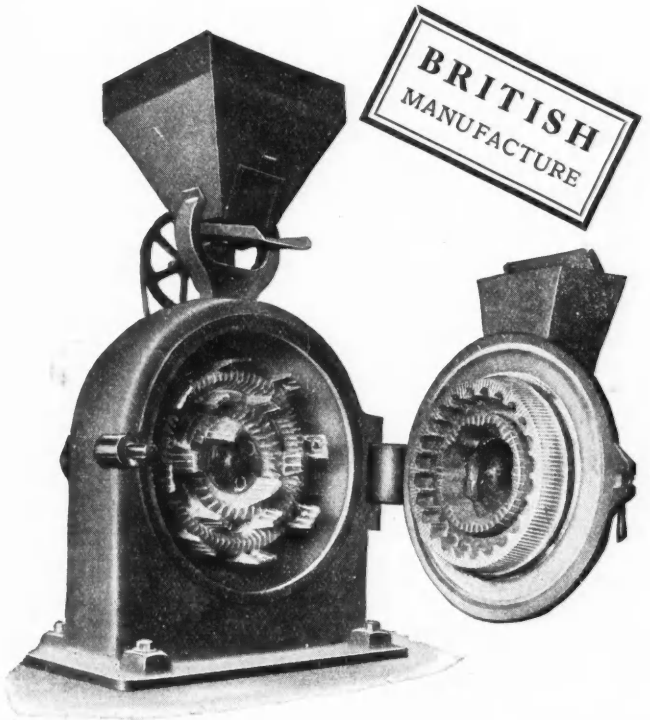
diffusion and dialysis

manufacture protected by patents

JENA^er GLASWERK SCHOTT & GEN., JENA

Agent: **C. Myers, London SW1,** Grosvenor Place 31/32

THE PULMAC STANDARD MILL



FOR

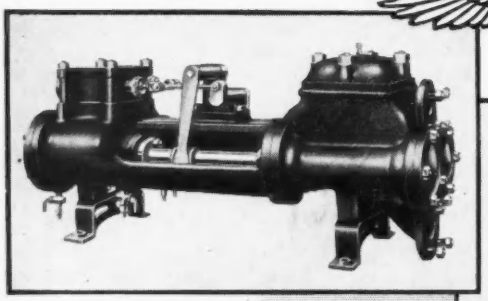
ALFALFA
ASPHALT
BAKELITE
BASIC SLAG
BAUXITE
BITUMEN
BONE ASH
BORAX
CASEIN
CELLULOSE ACETATE
CHALK (Dried)
CHEMICALS
CHINA CLAY
CLAY (Dried)
COAL
COFFEE
DISTEMPER
EPSOM SALTS
FERTILISERS
GLASS
GELATINE
GYPSUM
INSECTICIDES
ISINGLASS
KAINIT
KIESELGHUR
LIMESTONE
LINSEED
MICA
MOULDED PRODUCTS
OYSTER SHELLS
QUININE
RAGSTONE
RESIN
SALT
SAWDUST
SEAWEED
SOAPSTONE
SPICES
SUGAR
SULPHUR
TALC
WHITING
WOOD CHIPS, &c. &c.

INTERNATIONAL PULVERISERS LTD.

70, Victoria Street, London, S.W.1

Telephone : VICTORIA 2958.
Test Station : 1, KENNINGTON GROVE, S.E.11
Telegrams : PULGRIND, SOWEST, LONDON

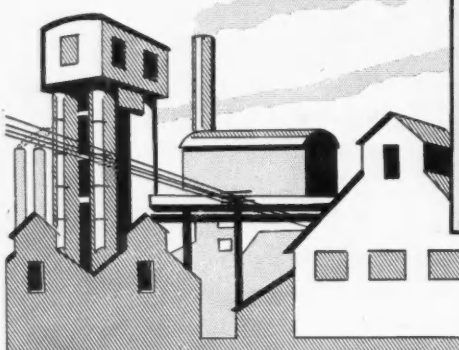
WORTHINGTON—SIMPSON

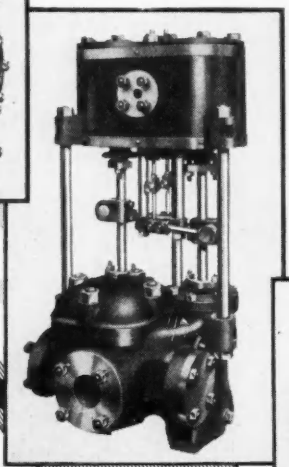


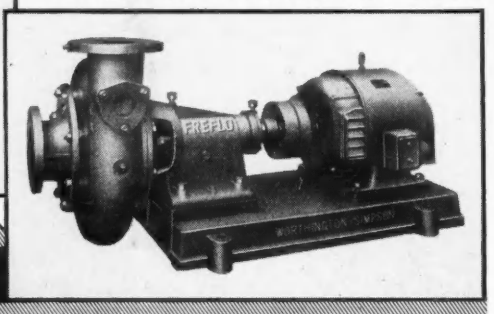
PUMPS FOR THE CHEMICAL INDUSTRY

Worthington-Simpson build a complete line of high efficiency Pumps for Chemical Plants. Standard units are available in a wide range of types and sizes for general water supply, boiler feeding, and other essential services, to operate up to any specified capacity. For the transfer of caustic and liquor solutions pumps can be supplied in special acid-resisting materials to counteract corrosion and wear.

Write for latest descriptive literature.







WORTHINGTON-SIMPSON, LTD., WORKS:- NEWARK-ON-TRENT

LIMESTONE AND ITS PRODUCTS

By ALFRED B. SEARLE

(Author of "Modern Brickmaking," etc.)

Royal 8vo. Containing over 700 pages and 123 illustrations. **42s.** *net.*

This is the only book in the English language which not only describes the principal kinds of limestones and the lime and other products obtainable from them, but also the various purposes for which these materials are used in the various industries.

By this means, readers who wish to sell Limestone, Lime, or the various Products can find industries which can use what they have to supply.

Other readers who wish to know the properties of the Limestone, Lime, or other Products which are requisite for the industries in which they are engaged will find them stated in clear terms with much other useful information.

The book has been written specially for Quarry Owners, Lime-burners, Cement-manufacturers, and all users of Limestone, Chalk, Lime, Fillers, etc., in a large number of industries.

Chemists, Students, and others will find it invaluable as a text-book on the Chemistry and Physics of calcium carbonate and its products.

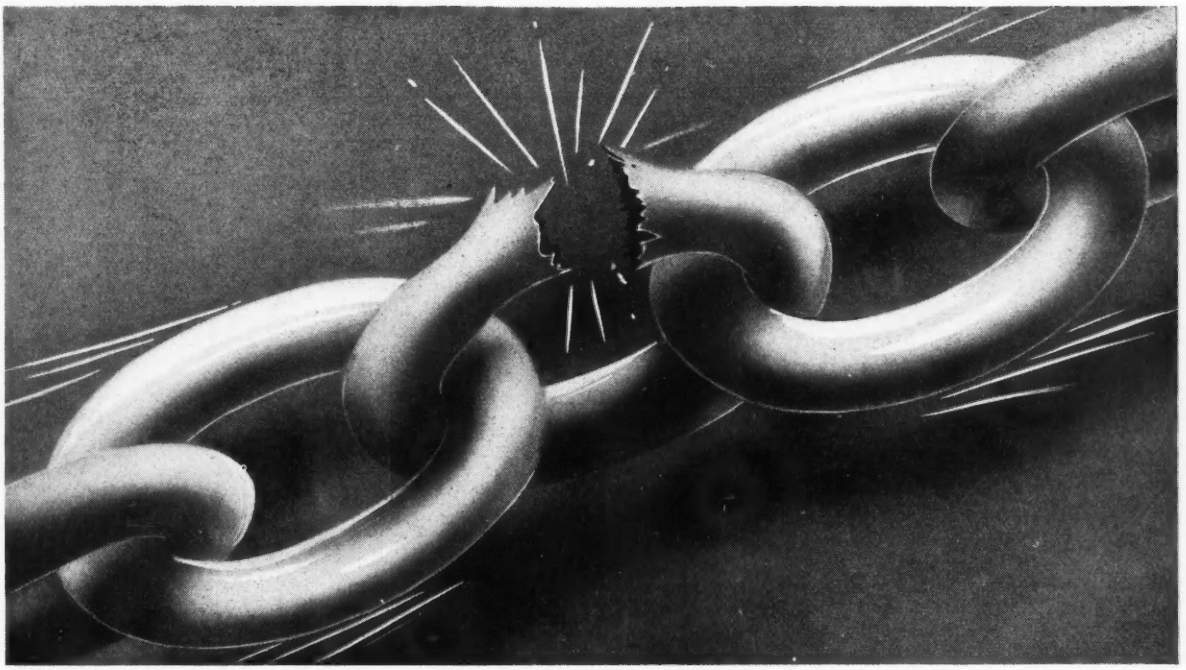
The subject of Hydrating Lime is dealt with fully, and much information of value to Builders and other users of this material is published for the first time.

"The only adjective that adequately describes Mr. Searle's book is encyclopædic; yet it is an encyclopædia far removed from most in that it is attractively written."

—Quarry and Roadmaking.

Published by

ERNEST BENN Ltd., Bouverie House, Fleet Street, London, E.C.4



A CHAIN

is as strong——

In the same way, plant is only as strong as its weakest joint.

That is why our Research Laboratories have devoted their energies during the past twelve months to painstaking investigation of the important problem of the jointing of metals.

The results have been extraordinarily successful and there has been produced a series of brazing alloys of low melting point, great strength, and increased resistance to corrosion. Two booklets tell of these new alloys. Would you care to have copies? No. 90 describes "Sil-fos" a Brazing Alloy for use on brass, bronze and copper.

No. 92 describes our range of Matthey Jointing Alloys and Fluxes for use on Nickel Alloys, Steel, Stainless Steel and other metals.

JOHNSON, MATTHEY & Co., LIMITED

71/73, VITTORIA ST, BIRMINGHAM, 1 73/83, HATTON GARDEN, LONDON E.C.1 38, BATH ST, GLASGOW, C.2

PACK in PAPER

. . . there is no better method for perishable or contaminating chemicals . . .

These are the reasons why

1 Scientifically-designed Paper packing is porous to air. It permits the contents to "breathe."

2 Medway Paper Sacks resist moisture and harmful action of the sun. They protect hygroscopic materials from the atmosphere generally.

3 Paper sacks and liners cannot contaminate—they are used only once. They are hygienic.

4 Paper sacks are non-returnable—carriage on returned empties is thus eliminated.

Write for prices and samples of MEDWAY PAPER SACKS and LINERS—the only hygienic and scientific packing

MEDWAY PAPER SACKS & LINERS

Kraft Paper Sacks
Crepe Paper Sacks (Crepesacs)
Crepe Paper Liners

MEDWAY PAPER SACKS LTD. LARKFIELD, NEAR MAIDSTONE, KENT.

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY
Principal: B. MOUAT JONES, D.S.O., M.A. (Oxford)
UNIVERSITY OF MANCHESTER
(Faculty of Technology)

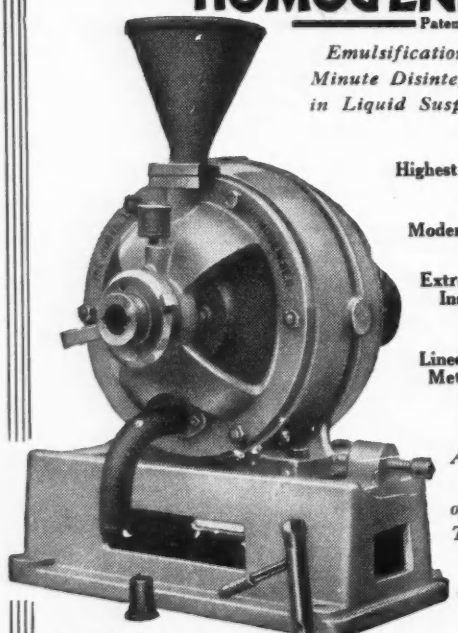
DEGREE COURSES IN TECHNOLOGY

The Prospectus gives particulars of the courses leading to the Manchester University Degrees (B.Sc.Tech., M.Sc.Tech., and Ph.D.) and Certificates in the Faculty of Technology in the following Departments :—

MECHANICAL ENGINEERING (Professor Dempster Smith, M.B.E., M.Sc.Tech., M.I.M.E.)
ELECTRICAL ENGINEERING (Professor John Hollingworth, M.A., D.Sc., A.C.G.I., M.I.E.E.)
MUNICIPAL ENGINEERING (R. J. Cornish, M.Sc., A.M. Inst. C.E.)
APPLIED CHEMISTRY, including General Chemical Technology, Metallurgy and Assaying, Fermentation Processes (including Brewing) Electro-Chemistry, Photography, Colouring Matters, Foodstuffs, Fuels, and Chemical Engineering. (Professor James Kenner, D.Sc., Ph.D., F.R.S.)
TEXTILE CHEMISTRY (Bleaching, Dyeing, Printing, and Finishing. Paper Manufacture.) (F. Scholefield, M.Sc., F.I.C., F.T.I.)
TEXTILE TECHNOLOGY (Professor W. E. Morton, M.Sc.Tech., F.T.I.)
BUILDING (W. B. McKay, M.Sc.Tech., M.I.Struct.E.)
INDUSTRIAL ADMINISTRATION (Post-Graduate Certificate Course) (K. G. Fenelon, M.A., Ph.D.)

Prospectus will be forwarded free on application to the Registrar, College of Technology, Manchester, 1.

THE HURRELL HOMOGENISER
Patent 214308



Emulsifications and Minute Disintegrations in Liquid Suspensions.

◆ Highest Efficiency.
◆ Moderate Cost.
◆ Extreme Ease of Installation.
◆ Lined with Monel Metal or other alloys.
◆ *Automatic Control of Rate of Treatment.*
Self Cleaning.
◆

Full particulars from
G. C. HURRELL & CO., Ltd. 'Phone: Greenwich 172
Old School Works, Woolwich Rd., Charlton, S.E.7

THE CONTAINER THAT FILLS EVERY REQUIREMENT

BROWN'S
(Rivetted)
PLYWOOD KEG

For all purposes.

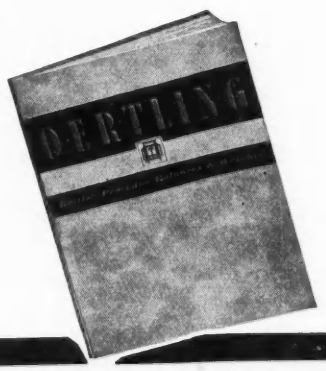
Enquiries Solicited.

BROWN & Co
Waterloo Saw Mills,
McALPINE STREET,
GLASGOW

Aperiodic, Prismatic, Reflecting Balance (New Design)
Oertling
Supplied to the Government Laboratory, National Physical Laboratory, University College, Messrs. Imperial Chemical Industries Ltd., Courtaulds Ltd., etc.
Code Word: PILOT
Price: £42-10-0
No. 53 GB.
Sensitivity: 0.1 milligram.
Capacity: 100 grams.
L. Oertling Ltd., 65, Holborn Viaduct, London, E.C.1. Tel.:

ALL THAT IS LATEST & BEST IN PRECISION BALANCE DESIGN

Oertling



● Post-war development in the design of Precision Balances is summarised in our new loose-leaf Catalogue now ready. Besides the most successful Aperiodic and Micro-Chemical Balances, we show a full range of instruments for analytical work and research. Many of the Balances illustrated have been designed specially for leading industrial laboratories and scientific institutions. Listing the finest British Precision Balances made, this is a catalogue of permanent reference value, and will gladly be sent without cost to manufacturers and to members of the chemical, physical, and allied professions. May we send you a copy?

L. OERTLING LTD., *Founded in London,* 1849

Showrooms : **65 Holborn Viaduct, London, E.C.1**

TAS/Or122a

Dick's
ORIGINAL
BALATA
BELTING
for
ALL DRIVES
R. & J. Dick Limited
GREENHEAD WORKS
GLASGOW, S.E.

VICTOR OVENS
ELECTRICALLY HEATED

With automatic temperature regulator.

Heating elements guaranteed for 2 years.

Please send for price list giving details of all types of Victor Ovens and Incubators.

Price of Oven as illustrated :—
10 x 8 x 8" £9 : 0 : 0
12 x 10 x 10" £9 : 15 : 0
14 x 12 x 12" £11 : 5 : 0
16 x 14 x 14" £12 : 15 : 0

J. W. TOWERS & CO. LTD. VICTORIA HOUSE, WIDNES.
AND AT 134 BROWNLOW HILL, LIVERPOOL

ZINC CHLORIDE
SOLID FUSED or SOLUTIONS

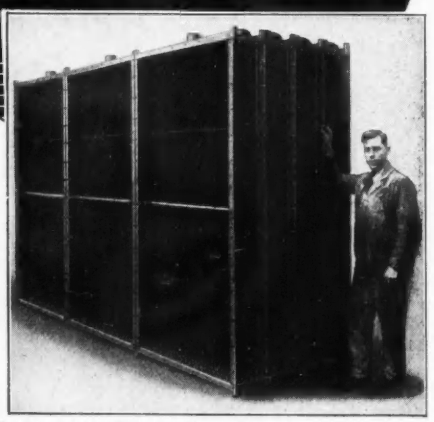
The product of
THE BRITANNIA LEAD CO LTD
NORTHFLEET
KENT

SOLID
Pure White
. . .
LIQUID
Any strength to buyers' specifications
Clear.
Suitable for all purposes

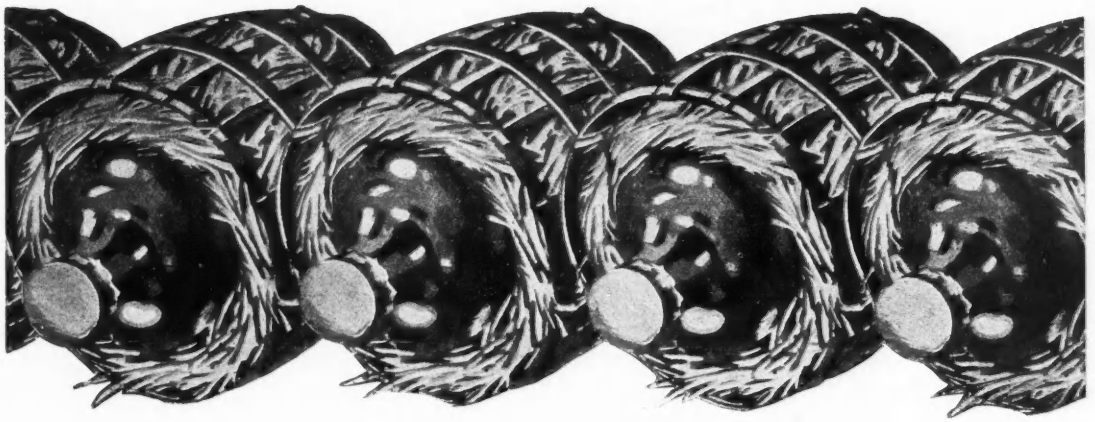
Samples and quotations for Home & Export Trades on request to—

METAL TRADERS LTD.
7 GRACECHURCH STREET, LONDON E.C.3. *Mansion House 7275*

"SPIRAL TUBE"
UNIT AND PLENUM TYPE
AIR HEATERS



Catalogue from Technical Department
THE SPIRAL TUBE & COMPONENTS CO., LTD.,
Osmaston Park Road, Derby.
London Office : 12 Pembroke Street, King's Cross, N.1



STAVELEY

CHEMICALS

ANILINE OIL	SULPHURIC ACIDS
ANILINE SALT	BLEACHING POWDER
CAUSTIC SODA	MIRBANE OIL
LIQUID CHLORINE	NAPHTHALENE
SODIUM HYPOCHLORITE	HYDROCHLORIC ACID

PYRIDINE

THE STAVELEY COAL & IRON CO LTD NR CHESTERFIELD

WELLS'

SPRAY

PLANTS

for all

PAINTING

No. 4
General Purpose
Spray Gun

Write for Catalogue H

A. C. WELLS & Co. LTD.
CHEETHAM, MANCHESTER, 3
Telephone: Blackfriars 8044. Telegrams: Unbreakable.

Fire!

Are your premises PROPERLY PROTECTED?

2 gallon size
Ref. No. E620.

BUY BRITISH GOODS
E.15

There is only one efficient method of covering the grave risk of FIRE to stocks of OILS, SPIRITS, VARNISHES or CHEMICALS! INSTALL VALOR FOAMERA EXTINGUISHERS without delay! Of the turnover type, are instantaneous in ACTION, and made in 1, 2, 3 gallon sizes; also in a special 1 gallon pattern for vehicles.

For large works we supply 20, 30 and 40 Imperial gallon VALOR FOAMERA ENGINES for indoors or outdoors.

We also make the well-known FYDRANT, NEW ERA and FYROUT SODA and ACID MACHINES for ordinary risks, and The VALOR C.T.C. type for cars and Electrical Establishments. All extinguishers are made to the SPECIFICATION of and APPROVED by the FIRE OFFICES COMMITTEE

Write to-day for List 51/V51 giving full particulars, also list of satisfied users.

Installed all over the world.

THE VALOR CO., LTD.,
Valor Works, Bromford, Erdington, Birmingham, England.
London: 120, Victoria Street, S.W.1.
Telephone: Victoria 3934

"POSTLIP"
(No. 633 Mill)
ENGLISH FILTER PAPERS

White and Grey Plain, Antique, Crinkled, and Embossed.

All sizes in Squares, Circles and Folded Filter Rolls made to order

Pure Filterings for Laboratory Work, and in quantities for all Industrial purposes.

See report of TESTS made by the National Physical Laboratory a copy of which will be sent on application together with free samples if required.

Postlip Filterings are stocked by all the leading Wholesale Laboratory Dealers

EVANS, ADLARD & CO., Ltd.
POSTLIP MILLS,
WINCHCOMBE, CHELTENHAM, ENGLAND

The Container for the Chemical Trade

Made in 400 sizes

strong but light—resilient enough to absorb bumps and jars—made in a variety of styles—those are the reasons which give

GUELPH CASKS

their High position in the Chemical Trade

If you are not using Guelph Casks, order a quantity and judge their protective power for yourself. You will certainly find them more satisfactory than other containers—and probably more economical too!

Write for a quotation and details to-day

THE GUELPH CASK, VENEER AND PLYWOOD CO. LTD.
WEST FERRY ROAD, MILLWALL, LONDON, E.14
Telephone: East 0279
Also at Manchester and Scotstown, Quebec, Canada

"STERLING BRAND"

Fine and Technical Chemicals.

Cadmium, Cobalt, Copper, Lead, Nickel, Oxides and Salts of Antimony, Selenium, Tin, Uranium, Zinc, etc.

Analytical Reagents, Etching Mixtures, Fluorides, Silico-Fluorides, Phosphates, Potash and Soda Salts, etc.

Send your enquiries

to

THOMAS TYRER & Co. Ltd.

STIRLING CHEMICAL WORKS

STRATFORD, LONDON, E.15

Telephone : MARYLAND 5575 (5 lines) **Telegrams : TYREMICUS, PHONE, LONDON**

CHEMICAL MANUFACTURERS

BETTER LIGHT AT LOWER COST

A special high-intensity unit, originally designed to solve a lighting problem in the Spondon works of British Celanese, Ltd.

It is not the current consumed, but the *use* made of the light produced, that determines whether your premises are well lit.

Heralded as the most radical lighting improvement of recent years, the G.V.D. System introduces a range of high-efficiency units which have produced

STRIKING RESULTS

Drastic reductions in current consumption and maintenance costs are accompanied by vast improvements in illumination.

The G.V.D. range includes units for all purposes, including DAYLIGHT lighting for laboratories, colour-matching, grading, etc.

You are invited to call for demonstrations or to ask for literature.

G.V.D. ILLUMINATORS LIMITED

ALDWYCH HOUSE, ALDWYCH, LONDON, W.C.

Phone : Holborn 7277-8

CARBONATE AMMONIA

THISTLE BRAND

LUMP	PHARMACY
POWDER	BAKING
(free running)	INDUSTRIAL

SOLE MAKERS:

THE WESTERN CHEMICAL CO. (PAISLEY) LTD.

SANDYFORD WORKS PAISLEY

A SUGGESTION FOR INCREASED SALES

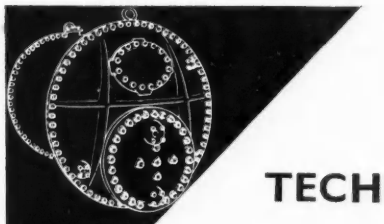
Week by week THE CHEMICAL AGE is diligently read by the executives of nearly all the principal firms in the Chemical and Allied Trades.

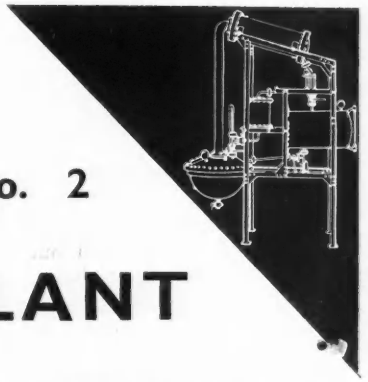
It is read for the wealth of information that it provides on every chemical topic, each page containing news or information of paramount interest to some section or other of the Industry.

Let THE CHEMICAL AGE advertisement pages carry news of your products to its hosts of readers. You could not select a medium with a greater power of penetration or one whose distribution covers such a wide and varied field.

For details write to :

THE PUBLISHER,
THE CHEMICAL AGE,
154 FLEET STREET, LONDON, E.C.4





TECHNICAL CAUSERIE No. 2

DISTILLATION PLANT

Batch Stills ? Yes.

Continuous Stills ? Our speciality.

Stripping Columns ? Yes. Analysers, Beer Columns, etc.

Rectifying Columns, of course, for concentration, with or without " side stream " ancillary apparatus.

Purifying Columns for removal of high or low boiling fractions.

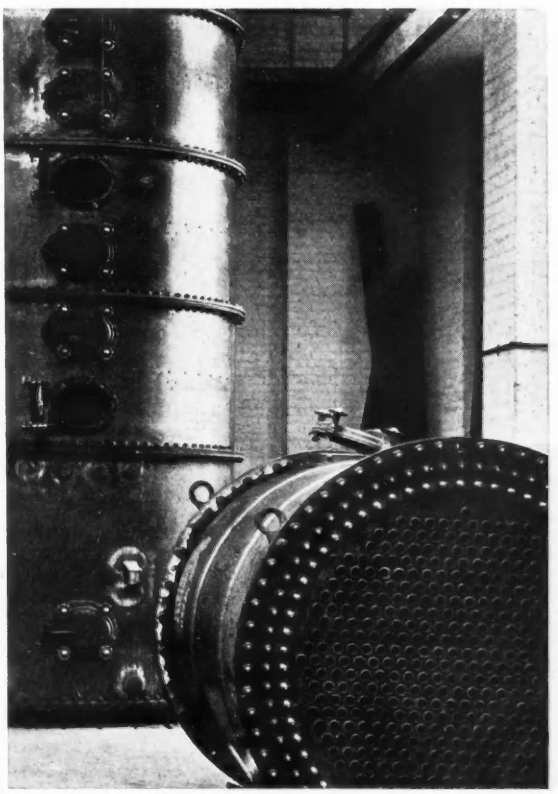
Then, naturally, appropriate condensers, heat exchangers, eprouvettes, automatic steam regulators, feed control tanks—the complete scheme, in fact, from A to Z.

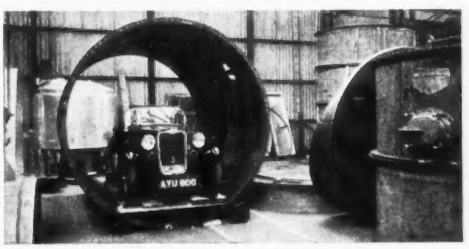
The types ? Some perforated plate types, many bells and chimney types, **also A.P.V. patent type combining advantages of both.**

Aluminium Stills only ? Certainly not.

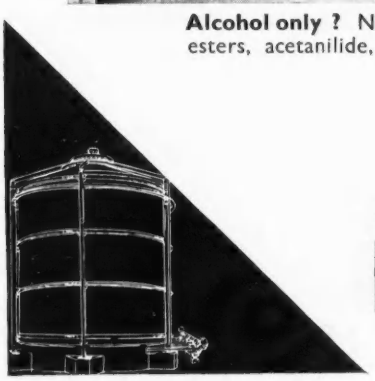
Copper ? Very, very many. Plants totalling over 300,000 lbs. throughput per hour built in nine months !

Stainless Steels bells and chimneys ? If you wish. They are covered by a recent patent of ours.





Alcohol only ? No. We have built stills for acetone, acetic acid, solvent recovery, esters, acetanilide, essential oils, and all kinds of products—even water !



APV

ALUMINIUM PLANT AND VESSEL CO. LTD.

POINT PLEASANT · WANDSWORTH

S.W.18.

SAP EXTRACTION PRESS

Designed by Dr. W. LEACH, Ph.D.
Dept. of Botany, The University, Birmingham.

WRITE FOR A SOIL LIST, GIVING DETAILS OTHER

COPY OF OUR 1936 EDITION, OF THIS AND APPARATUS

The important features of this press are: (a) Very little sap is lost owing to the small clearance between the barrel and the plunger, and (b) the expressed sap is run off while the pressure is being applied, and has not to be subsequently poured out of the apparatus.

A. GALLENKAMP & CO. LTD.
17-29, SUN ST., and 1-3, CLIFTON ST.,
FINSBURY SQUARE, E.C.2.

MIXING

THE...
"AUTOSELL" MIXER
PATENT NO. 260745
For...
PASTES, MASSES, GUMS, SEMI-LIQUIDS, ETC., ETC.
In Acid-Resisting Metal, Ebonite, Etc.
Features—Free Revolving Head; Stirrers Instantly Removed; Interchangeable Pans; Ball Bearings. From 2½ to 40 Gallons.
Also
Grinding Machines; Sifters; Mixing Machine for All purposes; Emulsifiers; Magnetic Separators

W. ROWLANDSON & CO.
75N, MARK LANE, LONDON, E.C.3
TELEPHONE—ROYAL 3634

For CHEMICAL & ALLIED TRADES

ACID RESISTING CEMENT & LININGS

For PICKLING TANKS, FLOORS, DIGESTERS, KIERS, STONE, BRICK, WOOD AND IRON VESSELS

PICKLING TANKS 60 FEET LONG WORKING SUCCESSFULLY

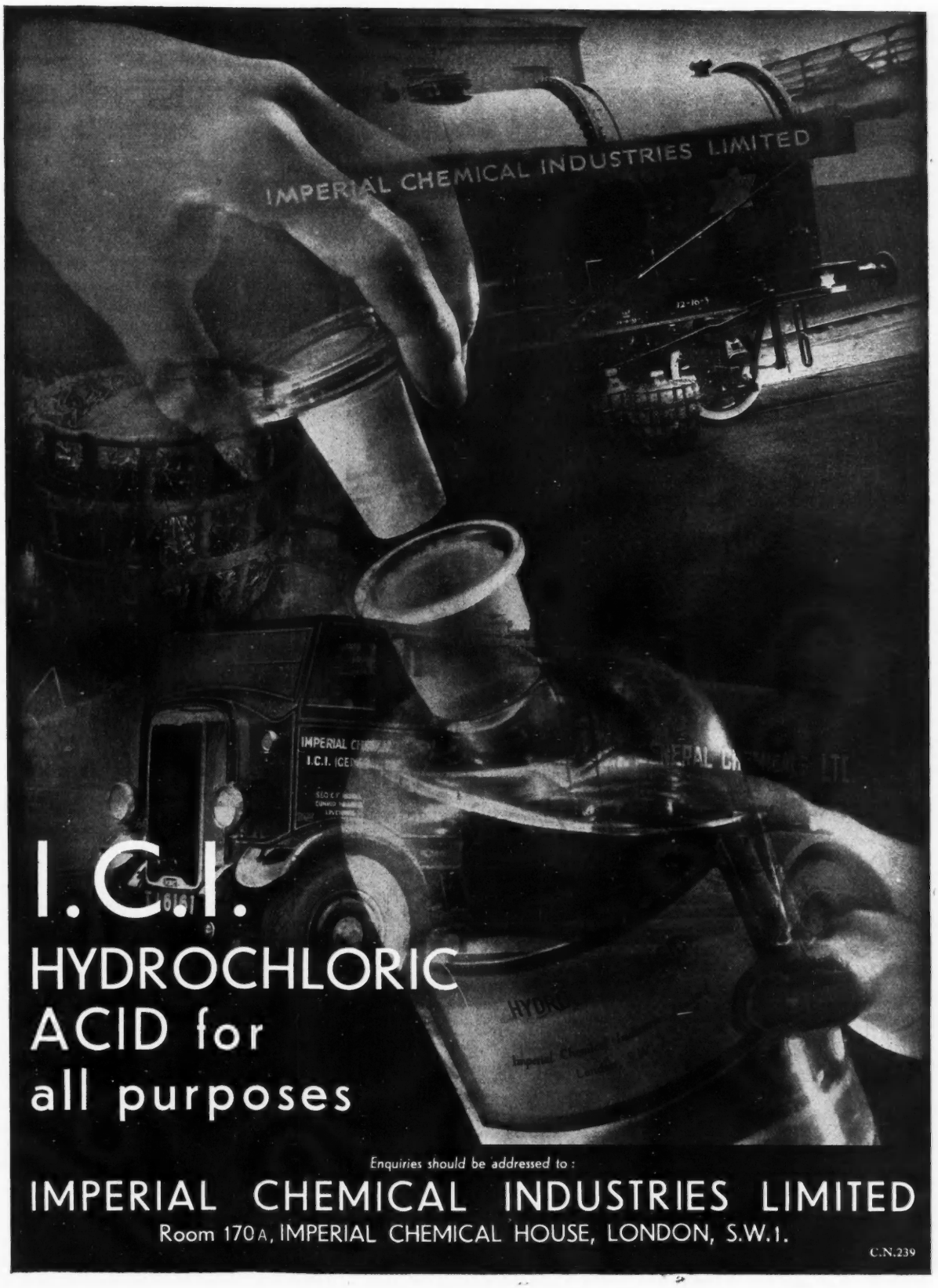
RIZISTAL

AN ALL BRITISH PRODUCT

RIZISTAL TRADE MARK

RESISTS
HCl, H_2SO_4, HNO_3,
Formic, Acetic, Oxalic,
Hydrogen & Sodium Peroxides,
BISULPHITES, HYPOCHLORITES,
AQUA REGIA & MIXED ACIDS,
NASCENT HALOGENS, ACIDS & ALKALIES,
UNDER STEAM PRESSURE
NEARLY 40 YEARS' EXPERIENCE

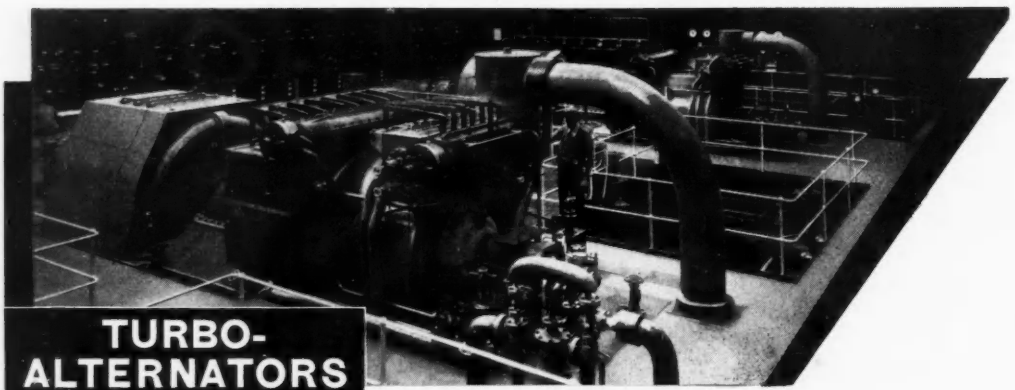
SOLE MAKER
JOHN L. LORD
WELLINGTON CEMENT WORKS
TELEGRAMS: "CEMENT"
PHONE: BURY 617
BURY, LANCASHIRE


IMPERIAL CHEMICAL INDUSTRIES LIMITED
I.C.I.
HYDROCHLORIC
ACID for
all purposes
Enquiries should be addressed to :
IMPERIAL CHEMICAL INDUSTRIES LIMITED
Room 170A, IMPERIAL CHEMICAL HOUSE, LONDON, S.W.1.
C.N.239

B T-H

ELECTRICAL EQUIPMENT

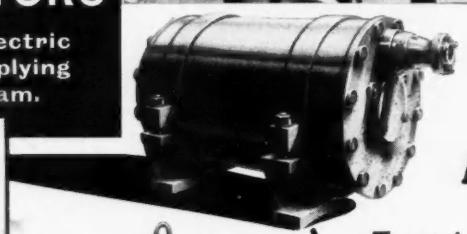
for the CHEMICAL INDUSTRY



TURBO-ALTERNATORS for generating electric power and supplying process steam.

Other **BTH** Products for the CHEMICAL INDUSTRY *include :—*

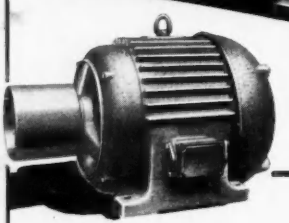
TRANSFORMERS
SWITCHGEAR
MOTOR-GENERATORS
ROTARY CONVERTERS
MOTOR CONVERTERS
RECTIFIERS
A complete range of POWER FACTOR IMPROVEMENT PLANT
MAZDA LAMPS



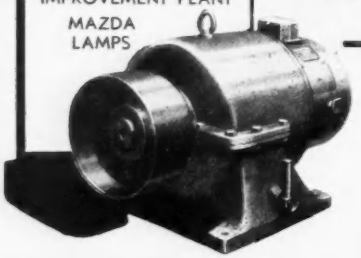
ELECTRIC MOTORS

For Every Drive

Types include :—



- **FLAMEPROOF** for situations where inflammable gas or liquids may be present.
- **TOTALLY-ENCLOSED FAN-COOLED** for use in dusty, moisture-laden and corrosive atmospheres.
- **GEARED MOTOR UNITS** for slow speed drives.



- **CONTROL GEAR** *A complete range—* Contactor, Air, or Oil-break types.

For Anything Electrical CONSULT BTH

BTH RUGBY

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED, RUGBY, ENGLAND

A1818

ALWAYS AT YOUR SERVICE

B. LAPORTE LTD., LUTON.

PHONE : LUTON 891 (3 LINES). GRAMS : "LAPORTE, LUTON."

FILTRATION EQUIPMENT

The wide range of Filters at our disposal and our extensive experience place us in the best position to advise you correctly in the selection of your filtration equipment.

- **OLIVER Continuous Drum Filter.**
- **OLIVER Continuous Disc Filter.**
- **DORRCO Continuous Drum Filter.**
- **SWEETLAND Pressure Filter.**
- **KELLY Pressure Filter.**

DORRCO

DORR-OLIVER COMPANY LIMITED

ENGINEERS

ABFORD HOUSE, WILTON ROAD (VICTORIA), LONDON, S.W.1

Dorr-Oliver technical services and equipment are also available from the following companies :
HOLLAND: Dorr-Oliver N.V., The Hague. FRANCE: Societe Dorr-Oliver, Paris. GERMANY: Dorr Gesellschaft m.b.H., Berlin
SCANDINAVIA : A/B Hedemora Verkstader, Hedemora, Sweden. POLAND: The International Shipbuilding & Engineering Co. Ltd., Danzig.
AUSTRALIA: Crossle & Duff Pty. Ltd., Melbourne. CANADA: The Dorr Co. Inc., Toronto. SOUTH AFRICA: Edward L. Bateman (Pty.) Ltd., Johannesburg.
JAPAN: Andrews & George Co, Inc., Tokyo. U.S.A.: The Dorr Company, Inc., Oliver United Filters Inc., New York.

ACID-PROOF TANK LININGS

ACID-PROOFING WORK. Process tanks by special construction methods for most Industries—Bulk Storage of Acids—Acid-proof Flooring (several types) for all Industries—Chimney Linings—Acid-proof Cement and Concrete work (World Patents) Acid Rubber Linings.

Free advice given on any Acid-proofing problem by our Technical Staff—fully equipped Laboratory for tests and experiments.

Prodorite acid-proof tanks installed at the works of a well-known Non-Ferrous Metal company.

INDUSTRIAL FLOORING Detailed schemes for all Industrial Flooring problems (Acid and Non-acid).

Full range of special surfaces Non-dusting — Non-slip — Hard Wearing—Oil-proof—laid *in situ*. Range of machine-ground Tiles in colours for decorative schemes. Range of special pressed Tiles for industrial hard-wearing service, including steel-faced Tiles. Drawings and Estimates free.

REFRACTORY " Kestner Cement and Concrete." An air setting refractory—unique, simple to use and extremely useful. Rock hard in 48 hours after setting or casting. Used on some of the largest Power Station Work in the Kingdom.

FLAT ROOFING. Prodor system of flat roofing—Insulating—Sound Deadening—Wear-resisting. Our flat roofing system is a great advance on usual practice—difference in temperature between face and back recorded up to 35°F. Drawings and Estimates free.

PAINTS. Prodor Brand Industrial and Floor Paints, and Prodorlac, the Anti-Sulphuric Black.

CLEANER AND MORE EFFICIENT DE-SCALING AND PICKLING ROOMS

PRODORITE LIMITED
EAGLE WORKS
WEDNESBURY - - STAFFS

PRODORITE LTD

The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

Vol. XXXIII No. 861 Published every Saturday December 28, 1935

CONTENTS

EDITORIAL

The Chemical Industry in 1935 581-582

FEATURES

Presidential Greetings—The Chemical Society, The Institute of Chemistry, The Society of Chemical Industry 583-584

Imports and Unemployment. By Eben Wallace (Chairman of the Association of British Chemical Manufacturers) 584

Chemical Industry under the New Parliamentary Regime. By Dr. E. F. Armstrong 585-586

Conditions in the Heavy Chemical Industry in 1935. By P. Parrish . 587-590

Essential Oil Industry—Conditions in France 590

Chemical Engineering in Retrospect and Prospect. By Hugh Griffiths 591-593

Calcium Carbide—New Specification 593

Colloid Chemistry in 1935. By William Clayton 594-596

Institute of the Plastics Industry 596

Progress in the Colouring and Finishing of Textile Materials. By A. J. Hall 597-598

Society of Public Analysts—Leather Trades Chemists 598

Fatty Oils and Soaps in 1935. By Professor T. P. Hilditch . . . 599-600

The Nitrogen Industry in 1935. By E. B. Maxted 601-603

National Federation of Paint Manufacturers 603

The Work of the Public Analyst. By Edward Hinks 604-605

I.C.I. Capital Reduction Scheme 605

The Year's Progress in Solvents and Plasticisers. By Thos. H. Durrans 606-607

The Pharmaceutical Society 607

ANNUAL REVIEWS FROM THE SOCIETIES: Newcastle Chemical Industry Club—British Plastics Federation—Society of Dyers and Colourists—Ceramic Society—Society of Glass Technology . . 608-609

Micro-Organisms and Colours 609

The Voice of the Industry 610-615

From Week to Week 616

Chemical Industry Inventions 616

Publishers' Notice

A copy of THE CHEMICAL AGE will be sent every week to an address in the United Kingdom for 21/- per annum. The prepaid subscription for addresses abroad is 26/- per annum. Cheques, Money Orders, and Postal Orders should be made payable to Benn Brothers, Ltd. On publication of THE CHEMICAL AGE YEAR BOOK a copy will be sent to every subscriber on our books.

Communications relating to editorial matter should be addressed to the Editor, who will welcome contributions dealing with modern chemical developments. Communications relating to advertisements, subscriptions or general matters should be addressed to the Advertisement Manager.

PUBLISHED FROM BOUVERIE HOUSE, 154, FLEET ST., LONDON, E.C.4

Telegrams: ALLANGAS FLEET LONDON. Telephone: Central 3212 (10 lines).

(Closed on Saturdays in accordance with the adoption of the five-day week by Benn Brothers, Limited).

GLASGOW: 116 Hope Street (Central 3970). BIRMINGHAM: Daimler House, Paradise Street (Midland 0747).

ACID STORAGE PLANTS

IN

HATHERNWARE

CHEMICAL
STONEWARE

Illustration shows erection of a Plant for bulk storage of H.Cl., comprising two 3,000 L. Vessels and Covers, with Piping and Valves, cone-end type, supplied complete with couplings.

QUOTATIONS FREE—WITHOUT OBLIGATION

HATHERNWARE LTD

[formerly: HATHERN STATION BRICK & TERRA COTTA CO., LTD.]

DEPT. C.A., LOUGHBOROUGH, ENGLAND

Telegrams Bricks, Loughborough. Telephone: Hathern 61

MONEL METAL*

versus

SULPHATE *of* AMMONIA

The advantages of Monel Metal Centrifugal Baskets for use in contact with Sulphate of Ammonia are beyond dispute. All leading plants have them.

Monel Metal ensures efficient and economical working in this and many other branches of the chemical industry. Perhaps its remarkable combination of physical and corrosion-resisting properties may be of value to you.

Our publications dealing with the uses of Monel Metal and Nickel in the chemical industry will be sent free on request, together with a loose-leaf binder, for the series to be issued in 1935.

Please send me your publications dealing with Monel Metal and Nickel in the Chemical Industry.

Name.....

Address.....

.....

To
HENRY WIGGIN & CO., LTD.,
Thames House, Millbank, London, S.W.1.

35 MH6

CENTENARY YEAR

1835 1935

HENRY WIGGIN & Co LTD

THAMES HOUSE, MILLBANK, LONDON S.W.1.

**"MONEL METAL" is a registered Trade Mark.*

HOWARDS'

ETHYL LACTATE

BOILING RANGE	FLASH POINT	DENSITY
145°-190° (90%).	125° F.	1·035

Acidity guaranteed not higher than 0·025%. No Residual Smell.

NOTE! THE FLASH POINT OF

HOWARDS' **DIACETONE ALCOHOL**

HAS AGAIN BEEN RAISED AND IS NOW

GUARANTEED NOT LESS THAN 130° F.

OTHER PROPERTIES AS FOLLOWS

BOILING RANGE 145°-160° C. (90%). :: :: DENSITY 0-941

COLOUR WATER WHITE.

Samples and particulars from the Manufacturers

HOWARDS & SONS LTD., ILFORD, Nr. LONDON

Telephone : ILFORD 1113 (6 lines). Telegrams : "QUINOLOGY, ILFORD."

OLEUM (all strengths)

Sulphuric, Battery, Dipping, Muriatic, Nitric, and Mixed Acids.

SPENCER CHAPMAN & MESSEL Ltd.
With which is amalgamated WILLIAM PEARCE & SONS, Ltd.
WALSINGHAM HOUSE, SEETHING LANE, E.C.3.
Telephone: Royal 1166. Works: Silvertown E.16
Telegrams: "Hydrochloric Fen, London."

LACTIC ACID

SULPHONATED OILS
TANNERS' MATERIALS

BOWMANS (WARRINGTON), LTD.
CHEMICAL MANUFACTURERS
Moss Bank Works : : : Near WIDNES.

THE SCIENTIFIC GLASS-BLOWING CO.
(MANCHESTER)

EXPERTS FOR ALL KINDS OF SPECIAL DESIGN APPARATUS IN **SODA, PYREX, JENA** AND OTHER LEADING RESISTANCE GLASSES, **QUARTZ** AND **VITREOSIL.**

Colorimeter and Nessler tubes with fused on bottom can be made to any length and diam. up to 50 m/m.

PYROMETER & COMBUSTION TUBES IN PYTHAGORAS COMPOUND; gas tight at 1,400°C. maximum heating temperature 1,750°C. List with full particulars on application

SOLE ADDRESS:
12-14 WRIGHT STREET, OXFORD ROAD, MANCHESTER
'Grams "Soxlet" Manchester. 'Phone: ARDwick 1425.

BRITISH ASSOCIATION OF CHEMISTS

Unemployment Insurance. Over £10,000 paid out.
Legal Aid. Income Tax Advice. Appointments Bureau

Write for particulars to:—

C. B. WOODLEY,
C.R.A., F.I.S.A.
General Secretary B.A.C.
"EMPIRE HOUSE,"
175, PICCADILLY,
LONDON, W.1

'Phone: Regent 1611

FOR SALE

(2d. per word; minimum 18 words; 3 or more insertions, 1½d. per word per insertion. Sixpence extra is charged when replies are addressed to box Numbers.)

CHARCOAL, ANIMAL and VEGETABLE, horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—THOS. HILL-JONES, LTD., "Invicta" Mills, Bow Common Lane, London, E. Telegrams: "Hill-Jones, Bochurch, London." Telephone: 3633 East.

COMPLETE PAINT MAKING PLANT for IMMEDIATE SALE. Including Torrance 5-ft. Mill. Torrance Micro-Twin Paint Rolls. Raymond Mill. Two Oil-fired Lead Pots. Lodge Cottrell Multiclone Dust Separator. Paint Mixers, Tanks and Equipment.
JOSEPH PUGSLEY AND SONS, LTD., Lawrence Hill, Bristol. Phone: 56037.

HYDRAULIC PRESSES, PUMPS, PIPING AND FITTINGS, large stock in London, erecting and fitting if required. THOMPSON AND SON, Maria Street, Millwall, London, E.14. East 3066.

MIXING MACHINE by Joseph Baker, pan 4 ft. × 4 ft. × 3 ft. deep, hand and power tipping, reversible blades, belt driven, with friction clutch. C. F. DAVIS, LTD., 60 Hatcham Road, Canterbury Road, Old Kent Road, London, S.E.15. New Cross 1147.

WANTED

(2d. per word; minimum 18 words; 3 or more insertions, 1½d. per word per insertion. Sixpence extra is charged when replies are addressed to box Numbers.)

EDWARD RUSHTON, SON AND KENYON (Established 1855).
Auctioneers' Valuers and Fire Loss Assessors of CHEMICAL WORKS, PLANT AND MACHINERY,
York House, 12 York Street, Manchester.
Telephone: 1937 (2 lines) Central, Manchester.
Telegrams: "Russoken, Manchester."
And Bardon Chambers, 13 Infirmary Street, Leeds, 1.
Telephone: 26154.

GRINDING of every description of chemical and other materials for the trade with improved mills.—THOS. HILL-JONES, LTD., "Invicta" Mills, Bow Common Lane, London, E. Telegrams: "Hill-Jones, Bochurch, London." Telephone: 3633 East.

WANTED—One copy of THE CHEMICAL AGE, dated July 19th, 1919, June 30th, 1931, February 3rd, 1934. Write The Publisher, THE CHEMICAL AGE, 154 Fleet Street, E.C.4.

PATENTS & TRADE MARKS

(2d. per word; minimum 18 words; 3 or more insertions, 1½d. per word per insertion. Sixpence extra is charged when replies are addressed to box Numbers.)

KINGS PATENT AGENCY, LTD. (B. T. King, C.I.M.E., Regd. Patent Agent, G.B., U.S.A., and Can.). Advice, Handbook, and Cons. free. 40 yrs. refs. 146a Queen Victoria Street, London, E.C.4. 'Phone: City 6161.

PATENTS obtained, trade marks and designs registered, at home and abroad.—GEE AND CO. (Patent and Trade Mark advisers to THE CHEMICAL AGE), 51-52 Chancery Lane, London, W.C.2. Telephone: Holborn 1525. Established 1905.

PRACTICAL HINTS ON PATENTING Sent Free on Application. THE IMPERIAL PATENT SERVICE, Patent Agents and Consulting Engineers, First Avenue House, High Holborn, W.C.1. Preliminary Consultation Free.

REGINALD W. BARKER & CO. (Estab. 1886.) Patent and Trade Mark Agents, 56 Ludgate Hill, London, E.C.4. Booklets sent gratis. Phone: 5140.

WORKING NOTICES

(2d. per word; minimum 18 words; 3 or more insertions, 1½d. per word per insertion. Sixpence extra is charged when replies are addressed to box Numbers.)

THE Proprietor of British Patent No. 194,454, dated January 6, 1922, relating to "Improvements in Materials for Polishing and Cleansing," desires to arrange by licence or otherwise on reasonable terms to exploit the above and ensure its practical working in Great Britain. Inquiries to B. Singer, Steger Building, Chicago, Illinois.

THE
Institute of Chemistry of Great Britain & Ireland

Founded 1877. *Incorporated by Royal Charter*, 1885.

APPOINTMENTS REGISTER.

A Register of Chemists (Fellows, Associates and Senior Registered Students) who are available for appointments, or who are seeking to improve their positions, is kept at the office of the Institute. The facilities afforded by this Register are available (free) to Companies and Firms requiring the services of chemists, and to Universities, Colleges and Technical Schools requiring Teachers of Chemistry and Technology. A List of Laboratory Assistants is also available.

Particulars of the Regulations and Examinations of the Institute can be obtained (free), on application to the Registrar.

All communications to be addressed to The Registrar, Institute of Chemistry, 30, Russell Square, London, W.C.1.

Place your
GRINDING PROBLEMS
in our hands

WITH OVER 25 YEARS' EXPERIENCE
WE OFFER YOU PROMPT SERVICE WITH
MODERN PLANT AT LOW PRICES

FOR THE GRINDING, BLENDING AND PROPRIETARY PACKING OF

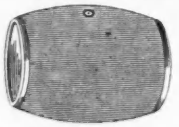
Raw Materials **Drugs** **By-Products**
Chemicals **Herbs** **Minerals**
Ores

THE CENTRAL PULVERIZING Co. Ltd.

Established 1908
32/34 Thomas Street, Burdett Road, E.14
Telephone : EAST 6964 (2 lines). *Telegrams* : CENTPULV, POP, LONDON

NEW & SECOND-HAND **STEEL DRUMS & BARRELS**

We hold the largest Stock in the Country, available for Immediate Delivery.



Works: Battery Wharf, Abbey Road, Barking, E.

VICTOR BLAGDEN & Co., Ltd., 4, Lloyds Avenue, London, E.C.3. Telephone: **ROYAL 6382 (5 lines)**

OVERCOME THAT OBJECTIONABLE ODOUR in your Turpentine Substitutes, Paints, Varnishes, Distempers, Floor and Furniture Polishes, etc., by using

VIOFLOR (REGD.)

Deodorant

Full particulars on application

CREPIN & DOUMIN LTD., 15, COOPER'S ROW, LONDON, E.C.3

Cables: DOVORIAN, FEN, LONDON. Telephone: ROYAL 2107

FINEST HYDRATED LIME.

A New Hydrated Lime Works producing finest quality material suitable for Chemical and Allied Trades can quote very advantageous prices for product delivered in paper bags, London or elsewhere.

Enquiries:

ATLAS SYNDICATE, LTD., ALDRINGTON BASIN, HOVE, or LONDON OFFICE. 'Phone CENTRAL 9176.

Telephone: **Clerkenwell 2030**

Telegraphic Address: **"Gasthermo, Smith, London."**

The mark of precision and efficiency. BRITISH MADE THROUGHOUT

If you use heat—it pays to measure it accurately

B. BLACK & SON

1, Green Terrace, Rosebery Avenue, London, E.C.1.

THERMOMETER MANUFACTURERS

(MERCURY IN GLASS TYPE)

Original Makers of the Improved, Gas filled, Permanent Thermometers for Laboratory and Industrial Processes.
Standard Thermometers of the highest accuracy covering over a range from minus 200 to plus 520 C.
The black filling in etchings will resist all solvents with the exception of those that attack the glass itself.
The National Physical Laboratory Certificates supplied, with any type.

Of all the principal Scientific Instrument and Laboratory Apparatus Manufacturers.

For service and satisfaction

Let us quote you for COMPLETE TAR PLANTS; NEW STILLS OR REPAIRS; RIVETED OR WELDED. Benzol Stills, Tanks, Jacketed Pans and all types of

STEEL PLATE WORK

for chemical processes.

LEEDS & BRADFORD BOILER CO., LTD.

STANNINGLEY, Nr. LEEDS

TRIBASIC PHOSPHATE OF SODA

Free Running White Powder

Price and sample on application to:

PERRY & HOPE, LIMITED, NITSHILL, GLASGOW

WE WOULD REMIND ADVERTISERS THAT "COPY" FOR DISPLAY ADVERTISEMENTS SHOULD REACH THIS OFFICE NOT LATER THAN FRIDAY PRECEDING WEEK OF PUBLICATION.

WOODEN VATS & TANKS

FOR THE CHEMICAL & ALLIED INDUSTRIES

TWO GENERATIONS OF EXPERIENCE IN VAT BUILDING IS AT YOUR SERVICE. SEND US YOUR SPECIFICATIONS AND LET US QUOTE.

ROBERT AIREY & SON VAT BUILDERS HUDDERSFIELD TEL 976

BI-METALS

For the

CHEMICAL INDUSTRY

Write for Booklet:

WILLIAM WILKINSON

Thermoflex Works,
SHUSTOKE, Warwickshire,
Telephone: COLESHILL 63.

Snow-White Light Oxide of Tin. Copper Oxide.

Oxides of:—
ANTIMONY.
COBALT.
CHROME.
MANGANESE.
NICKEL.
SELENIUM.
TITANIUM.
URANIUM.
ZINC.

GROUND BONE, FELSPAR, FLINT, FLUORSPAR, QUARTZ STONE, WHITING, Etc.
OXIDES OF ANTIMONY, ARSENIC, CHROME, COBALT, SMALTS, COPPER, IRON, MANGANESE, NICKEL, TIN, TITANIUM, URANIUM, ZINC, Etc.
CARBONATE & SULPHATE OF BARYTES
REGISTERED
TRADE MARK
WENGERS. LTD.
CERAMIC COLOURS & CHEMICALS
ETRURIA, STOKE-ON-TRENT, England
COLOURS for POTTERS, GLAZED BRICK MANUFACTURERS, & GLASSMAKERS.
Samples & Price Lists Sent on Demand.
PREPARED ENAMELS for CAST & SHEET IRON, COPPER & JEWELLERY.

CADMIUM SULPHIDE, RUTILE.

All kinds of Chemicals for Vitrifications.

PYRAMID CONES for Testing Temperatures

5" Dial Model D. Black **25/-**
Do. Do. Chromium plated **28/-**

HUMATAGRAPH HYGROMETER

AT LAST! A RELIABLE HYGROMETER AT A MODERATE PRICE

A NEW hygroscopic substance cone fibre has proved itself to be the ideal substance for the sensitive element in a humidity meter. Many forms of illness are aggravated if not caused by damp rooms, damp beds, etc. Models for home and industrial purposes.

A steadily increasing interest is being taken by the general public in humidity.

An attractive variety of models are offered at popular prices.

From your dealer or

C. L. BURDICK MANUFACTURING CO.

40-44 HOLBORN VIADUCT, LONDON, E.C.1

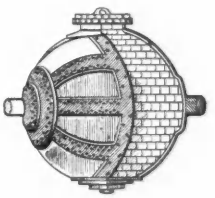
F. HAWORTH'S

Acid Resisting Cement and Tiles

LININGS FOR VESSELS OF ANY DESCRIPTION, OPEN OR UNDER PRESSURE. THE CEMENT WITH CO-EFFICIENCY OF EXPANSION TO MILD STEEL. EXTENSIVELY USED IN CELLULOSE & COTTON NITRATION PLANTS, ETC.

If you are troubled with corrosion from Acids, Alkalies or other Factors my 35 years' practical experience is at your service and applied to every job. Prospective clients can view plants where kiers lined in 1905 are still intact and working under 80lbs. per square inch pressure withstanding varying concentrations of Acids.

SUPPLIED TO THE LEADING CHEMICAL AND ALLIED INDUSTRIES.



F. HAWORTH, Peel Brow, Ramsbottom, Lancs.

ACID RESISTING CEMENT MANUFACTURER

'Phone: RAMSBOTTOM 326.

THE LAMPLOUGH MATCHING LAMP

ACCURATE

PERMANENT

NEVER VARIES (—as daylight does)

BRITISH

Indispensable in any Industry with a colour basis

For over ten years the **Lamplough** has held the highest reputation as an accurate and reliable source of artificial daylight for Colour Matching, Comparison and Recognition. Obtainable direct or through the leading Firms of Laboratory Furnishers. Write for full particulars.

Enquiries from factories in Yorkshire should be addressed to the local representative: N. Lynn, 20 Rydal Avenue, Frizinghall, Bradford

RESTLIGHT LIMITED, 16 DOUGHTY STREET, LONDON, W.C.1

Do you want second-hand Chemical Plant or Accessories?

YOUR PARTICULAR REQUIREMENTS ARE POSSIBLY ADVERTISED IN THE CLASSIFIED ADVERTISEMENT SECTION OF THIS ISSUE

"CALLOW ROCK"
SUPERFINE
HYDRATED LIME
FOR THE ALKALI, BLEACH, PAPER, RUBBER, GREASE and COLOUR TRADES, Etc.
THE CALLOW ROCK LIME CO., LTD.
7, Cheddar Road,
SHIPHAM, WINSCOMBE, SOMERSET
London Agents: W. K. Chandler & Co., 4, Lloyds Avenue, E.C.3

SKIN TROUBLES ARE COSTLY
"CRODOL" IS CHEAP
In :—
100 lbs. @ 7½ per lb.
50 lbs. @ 8d. per lb.
25 lbs. @ 10d. per lb.
10 lbs. @ 1/- per b.
5 lbs. @ 1/3 per lb.
Carriage paid
Drums Free.
It may be that you have never had a compensation case of Dermatitis among your workpeople.
But skin troubles may nevertheless be costing you money.
A man cannot work efficiently with sore and cracked hands.
If he is not giving you his most efficient work—you are losing money.
Why not supply your employees with a trial drum?—It will amply repay you.
Samples and literature upon request to sole manufacturer of "CRODOL" Anti-Dermatitis Ointment.
CRODA, LTD.,
4, Rawcliffe Bridge, Goole, Yorks.

'ANALAR'
LABORATORY CHEMICALS
are manufactured to the new standards of purity published in the volume :
'ANALAR' STANDARDS FOR LABORATORY CHEMICALS
Laboratory Chemicals conforming to these modern standards of purity are sold under the registered trade-mark 'ANALAR.'
This is a new designation chosen to replace the letters A.R. and for their own protection users of laboratory chemicals are requested to specify ANALAR on their orders.
HOPKIN & WILLIAMS, LTD.,
16-17, CROSS STREET, LONDON, E.C.1.

TAPS OF LIGNUM VITAE
Cut by a Special Patent Process No Cork Centres; very Durable. All Sizes from ¼ in. to 1 in. Bores.

PREMIER FILTERPRESS CO. LTD.
Finsbury Pavement House. London, E.C.2

Crude and Ground
KIESELGUHR
Clays for bleaching, filtering and other industrial purposes. Crude Magnesite, Cosmetic Talc, Bentonite, Suar and Crystal Lime, Nickel Sulphate (small crystals); Fluorspar, Feldspar, Manganese-Dioxide, Molybdenum, and other metals and earths in large quantity, prompt shipment. Also some Sandalwood Root and Logs.
HENRY RISING & CO.,
Est. 1903.
424 So. Broadway LOS ANGELES, California.

BONE ASH
PUREST AND FINEST
Highest Percentage of Tricalcic Phosphate
CAFFERATA & CO., Ltd.
BEACON HILL, NEWARK, ENG.

WOOD & FAIRWEATHER
Successors to
RICHARD HOYLE & Co.
FOR
BLACKS
which have stood the test of time.
NEWCASTLE-UPON-TYNE
ESTABLISHED 1798

ZULO Carboy Hampers

LEIGH & SONS
ORLANDO IRON WORKS
BOLTON